MUNICIPAL INFRASTRUCTURE AND IDP HOUSING REHABILITATION PROJECT

RECOMMENDED WASTEWATER TREATMENT FOR IDP COTTAGE SETTLEMENTS (Draft Report)

CONTRACT: AID-EDH-I-00-08-00027-00, TASK ORDER: AID-114-TO-11-00002

25 JULY 2012

This document was produced for review by the United States Agency for International Development. It was prepared by Tetra Tech for the Municipal Infrastructure and IDP Housing Rehabilitation Project, Task Order number AID-114-TO-11-00002 under the USAID Architectural and Engineering (A&E IQC).

MUNICIPAL INFRASTRUCTURE AND IDP HOUSING REHABILITATION PROJECT

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25 July 2012

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Mr. Bradley Carr
COTR
Office of Economic Growth
US Agency for International Development
11 George Balanchine Street
Tbilisi, 0131
Georgia

Re: Recommended Wastewater Treatment for IDP Cottage Settlements (Draft Report) For the Municipal Infrastructure and IDP Housing Rehabilitation Project

Dear Mr. Carr:
This report is being submitted to you in accordance with the requirements of task order no. AID-114-TO-11-00002 of contract AID-EDH-I-00-08-00027-00. It provides Tetra Tech's Draft Report on Recommended Wastewater Treatment for IDP Cottage Settlements for the Municipal Infrastructure and IDP Housing Rehabilitation Project.

Very truly yours,

Jeffrey W. Fredericks

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Acronyms

CM	cubic meter(s)
COP	Chief Of Party
COTR	Contracting Officer’s Technical Representative
DHS	Durable Housing Solution
GEL	Georgian Lari
GMIP	Georgia Municipal Infrastructure and IDP Housing Rehabilitation Project (the project)
GoG	Government of Georgia
ha	hectare(s)
HO	Home Office
IDP	Internally Displaced Persons
IL	Implementing Letters
km	kilometer(s)
M	linear meter(s)
MDF	Municipal Development Fund
MRA	Ministry of Refugee Affairs
PEA	Programmatic Environmental Assessment
SOW	Scope of Work
SQM	square meter(s)
STTA	Short Term Technical Assistance
TBD	To Be Determined
Tt	Tetra Tech
USAID	United States Agency for International Development
USD	United States Dollar
USG	US Government
WWTP	Wastewater Treatment Plant

1. Summary

USAID has requested that Tetra Tech carry out a study on alternatives for the sanitation upgrades for the cottage settlements to determine the most appropriate sanitation/waste water treatment technology to be used for the cottage settlements.

The purpose of this report is to present the preliminary findings based on a two week on-site assignment in Georgia.

As part of the work toward recommending wastewater treatment for IDP cottage settlements, visits were made to settlements on June 28 – July 3, 2012. Summary reports for these visits are included in Section 3 of this report. Additional maps and pictures are provided in Annex 1 for each cottage settlement. In Section 4, wastewater treatment technologies are discussed including:

- Septic Tank and Infiltration Drain Field Treatment
- Oxidation Ponds Wastewater Treatment
- Aerated Lagoon Biological Treatment
- Dry Toilets
- Activated Sludge Biological Treatment
- Constructed Wetlands
- Rotating Biological Contactors
- Biotal Biological Treatment
- Georgian Septic Tanks

The technologies described in Section 4 provide an analysis of the first five treatment technologies considered most appropriate for IDP cottage settlements. Each technology was evaluated for suitability and sustainability of treatment at settlements.

The recommended technologies are provided in Section 5. Biotal biological treatment is recommended as first choice for nine IDP cottage settlements and either septic tanks and infiltration drain fields or dry toilets like Enviro Loo are recommended as second choice.

Additional description of the Biotal biological treatment system is provided in Annex B and a list of Biotal installations in Georgia is provided in Annex C.

Preliminary findings and recommendations for the two week on-site assignment in Georgia are provided below.

Preliminary Findings:

1. Biotal biological treatment is appropriate for all nine IDP cottage settlements. Biotal is much simpler than conventional activated sludge treatment. A trained operator is not required and Biotal has many automatic settings that do not require the presence of an operator. Biotal can operate under many different conditions of sewage inflow, from high loadings to no sewage inflow for extended periods. Biotal is designed for

the type of conditions typical of small communities and IDP cottage settlements. It provides exemplary sewage treatment when other systems would develop problems and fail. The standard automatic programs of Biotal plants are made for household sewage applications like IDP cottage settlements.

2. Biotal biological treatment and central septic tanks with infiltration drain fields are both possible treatment technologies for six of nine IDP cottage settlements (Akhalsopeli, Skra, Shavshvebi, Khurvaleti, Tsilkani and Frezeti). Municipalities have expressed concern about the availability of sufficient land for these six settlements.

3. Septic tanks are not appropriate for three IDP cottage settlements with high groundwater tables. The water tables at Mokhisi and Teliani settlements are above 1 meter and the community leader at Berbuki indicated the groundwater table was only 0.5 meter deep. (For Berbuki, additional groundwater testing would be needed to determine if septic tanks are appropriate.)

4. For Mokhisi, Berbuki and Teliani IDP cottage settlements, dry toilets like Enviro Loo are recommended as the second choice. Dry toilets are rated high, but they are not available in Georgia and there are questions about their acceptance by IDPs.

5. The Metekhi IDP cottage settlement has showers and flush toilets. Wastewater is piped into a septic tank that discharges inadequately treated wastewater into a local irrigation drain. Improved wastewater treatment such as Biotal is needed at this settlement.

6. Two wastewater treatment systems are needed at Frezeti IDP cottage settlement because about half the settlement flows by gravity one direction and the other part flows in the opposite direction. There are 5-6 cottages that may not flow to either of these systems and thus may need septic tanks and infiltration drain fields or dry toilets.

7. Karaleti and Verkhvebi IDP cottage settlements are located near Gori and discharge wastewater to the Gori municipal sewer system. Additional wastewater treatment is not needed. Tserovani IDP cottage settlement has an activated sludge treatment plant. It has operational problems and needs additional attention.

Preliminary Recommendations:

1. Biotal biological treatment is recommended as the first choice for sewage treatment in nine IDP cottage settlements (Akhalsopeli, Skra, Shavshvebi, Khurvaleti, Tsilkani and Frezeti).

2. Central septic tanks and infiltration drain fields are recommended second for six of the nine settlements. These six settlements (Akhalsopeli, Skra, Shavshvebi, Khurvaleti, Tsilkani and Frezeti) have groundwater levels that permit infiltration drain fields. This septic tank technology is highly rated, but there is a concern expressed by municipalities that sufficient land is not available for these infiltration systems. For any of these settlements, if sufficient land is not available for infiltration drain fields, then Recommendation #2 would be dry toilets like Enviro Loo.

3. For Mokhisi, Berbuki and Teliani settlements, high groundwater tables do not permit installation of infiltration drain fields. For these settlements, dry toilet systems like Enviro Loo are recommended as the second choice. Dry toilets are rated high, but they are not available in Georgia and there are questions about their acceptance by IDPs.

4. After full assessment of the available technologies, BIOTAL is recommended as first choice for all nine IDP cottage settlements. First and second choice recommendations are provided below.

Recommended Wastewater Treatment for IDP Cottage Settlements

	Cottage Settlement	**Recommended**	**Recommendation #2**
1	Akhalsopeli	**Biotal** Biological Treatment	Central Septic Tank + Infiltration Drain Field*
2	Mokhisi	**Biotal** Biological Treatment	Dry Toilets like Enviro Loo
3	Skra	**Biotal** Biological Treatment	Central Septic Tank + Infiltration Drain Field*
4	Berbuki	**Biotal** Biological Treatment	Dry Toilets like Enviro Loo
5	Shavshvebi	**Biotal** Biological Treatment	Central Septic Tank + Infiltration Drain Field*
6	Khurvaleti	**Biotal** Biological Treatment	Central Septic Tank + Infiltration Drain Field*
7	Teliani	**Biotal** Biological Treatment	Dry Toilets like Enviro Loo
8	Tsilkani	**Biotal** Biological Treatment	Central Septic Tank + Infiltration Drain Field*
9	Frezeti	**Biotal** Biological Treatment	Central Septic Tank + Infiltration Drain Field*

Note: * Central Septic Tank + Infiltration Drain Field is #2 recommendation for cottage settlements 1, 3, 5, 6, 8 and 9. For any of these settlements, if sufficient land is not available for infiltration drain fields, then Recommendation #2 would be Dry Toilets like Enviro Loo.

2. Introduction

The United States Agency for International Development (USAID)/Caucasus Office of Economic Growth under is implementing the Municipal Infrastructure and IDP Housing Rehabilitation Project through the GoG's Municipal Development Fund (MDF) to upgrade municipal infrastructure in targeted municipalities, rehabilitate irrigation channels, and improve housing for Internally Displaced Persons (IDPs).

The dual shocks of Georgia's August 2008 conflict and the global economic downturn pose serious challenges to Georgia's economic stability. The conflict, crisis, and subsequent slowdown in economic growth and foreign direct investment have placed a severe strain on Georgia's national budget and its ability to finance core investments in critical regional development initiatives. Many years of decline in the quality, coverage and maintenance of basic services, including water supply, sewage, local roads, solid waste services, and irrigation systems have dramatically reduced Georgia's quality of life in rural areas and constrained private sector growth. Such degradation and instances of conflict-related damage have resulted in significant constraints to the productive capacity and quality of life of thousands of Georgians, including old and new IDPs, rural poor, and persons directly or indirectly affected by the 2008 conflict.

Under Component 3 Subcomponent 1: Provide Water and Sanitation Upgrades for Cottage Housing for IDPs from the August 2008 War, GMIP proposes to upgrade nearly 2,000 cottages located in 11 priority IDP settlements identified by the MDF for USAID funding support. The cottages were constructed by the GoG following the August 2008 war, and due to the emergency situation at the time, they were not fully equipped. The GoG, through GMIP, aims to improve them by providing water supply and upgrade sanitary conditions by providing drainage, showers, sinks, toilets, water taps, and sewage treatment renovations at cottage settlements that currently lack these facilities. These renovations will improve living conditions in the IDP settlements.

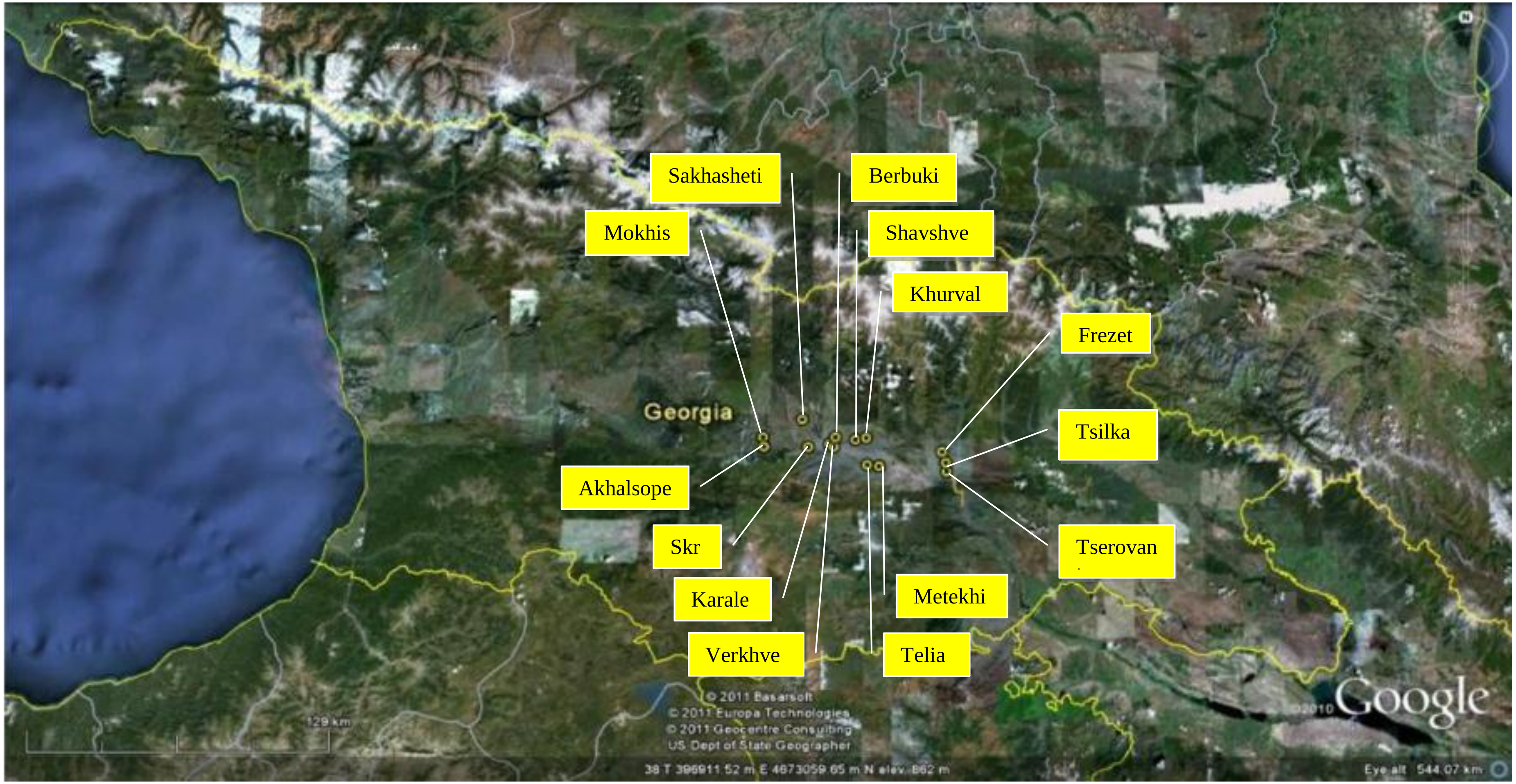
The type of sewage treatment system depends on the site-specific conditions at each cottage settlement, and the options available for treatment, their benefits and drawbacks, are discussed further in Chapter 3. Piping networks will be constructed at the settlements to drain wastewater to the treatment system. The entire system will be operated by gravity without requiring pumping systems.

3. Cottage Settlements

This section provides the map of each settlement showing the location of the recommended wastewater treatment technology and a summary write-up based on site visits to each cottage settlement. During the visit, James Gallup and Givi Varduashvili met with the community leader. We discussion the existing situation with water and sanitation and usually walked through the settlement, visiting cottages and latrines. We also discussed drainage and possible flooding and problems inside cottages with mold. We visited the proposed location of the wastewater treatment plant and possible locations for receiving the treated discharge. Fourteen settlements are covered in this section:

1. Cottage Settlement “Akhalsopeli”
2. Cottage Settlement “Mokhisi”
3. Cottage Settlement “Skra”
4. Cottage Settlement “Karaleti”
5. Cottage Settlement “Berbuki”
6. Cottage Settlement “Shavshvebi”
7. Cottage Settlement “Khurvaleti”
8. Cottage Settlement “Teliani”
9. Cottage Settlement “Metekhi”
10. Cottage Settlement “Tsilkani”
11. Cottage Settlement “Frezeti”
12. Cottage Settlement “Tserovani”
13. Cottage Settlement “Sakasheti”
14. Cottage Settlement “Verkhvebi”

Cottage Settlements' Map



1. Akhalsopeli Cottage Settlement

Date of Visit: 06.29.2012

Tetra Tech Team: James Gallup, Givi Varduashvili

Existing Situation:

Site visit was made to the settlement location proposed for the wastewater treatment system. Layout of the sewage collection network was considered as well as possible discharge locations. We inspected latrines and discussed drainage systems and cottage mold problems. Observations are provided below:

1. Wooden traditional toilets are in the back of each cottage property, wastes flow into shallow holes in the ground. It did not look like any of the latrines had been pumped out.

2. Drinking water is supplied from two headworks, situated on the mountain 3 km away from the settlement; water flows into 8 m^3 capacity tank. Water is distributed to common taps, located on the edge of the roads. Settlement has a water shortage in summer.

3. There are no storm water channels and water floods cottages during rain events, especially cottages lower than the road. We were told the World Bank was planning to install concrete drains.

4. Sewer slope from cottages to the proposed treatment plant is good.

5. Mold is a problem in 80 percent of cottages, typically on the north wall beginning from the ground upward.

6. Land for a treatment plant is available. Discharge would be to an irrigation drain.

7. There is concern about availability of sufficient land for an infiltration drain field. Land for a Biotal treatment plant would not be as much of a concern.

Recommendation:

1. Layout of cottages in settlement allows for gravity sewage collection piping networks that will flow to the treatment plant. There is concern about availability of sufficient land for the infiltration drain field. Land for a Biotal treatment plant would not be as much of a concern. Discharge from the treatment plant into a nearby irrigation drain is possible. The community leader did not expect any problems with the discharge to the drain.

2. Wastewater treatment using Biotal or septic tank/infiltration drain fields is possible. Land is a concern with the infiltration drain fields.

2. Mokhisi Cottage Settlement

Date of Visit: 06.29.2012

Tetra Tech Team: James Gallup, Givi Varduashvili

Existing Situation:

Site visit was made to the settlement location proposed for the wastewater treatment system. Layout of the sewage collection network was considered as well as possible discharge locations. We inspected latrines and discussed drainage systems and cottage mold problems. Observations are provided below:

1. Wooden traditional toilets are in the back of each cottage property, wastes flow into shallow holes in the ground. Surface runoff also flows into the holes. It did not look like any of the latrines had been pumped out.

2. Drinking water is provided from bore-holes; one bore-hole for two cottages. There is 50 ton capacity holding tank. Water is salty, irrigation water often used.

3. There is a bath house with flush toilets/showers that has been converted to a nursery and clinic. Septic tank installed with bath house, discharges to a soak pit.

4. Community leader indicated that drainage is better since ditches cleaned. Earlier report indicated that concrete stormwater drains were constructed poorly, improper slopes, water does not flow.

5. Sewer slope on map with treatment plant location shows slope in opposite location. New map prepared showing new location for treatment plant. Slope in settlement from cottages to the proposed treatment plant is good.

6. Mold is a problem in 100 percent of cottages, typically with damp walls. Groundwater may be only 2 m deep.

7. Land for a treatment plant is available. Discharge would be to an irrigation drain. There is concern about availability of sufficient land for an infiltration drain field. Land for a Biotal treatment plant would not be as much of a concern.

Recommendation:

1. Layout of cottages in settlement allows for gravity sewage collection piping networks that will flow to the treatment plant. There is concern about availability of sufficient land for the infiltration drain field. Land for a Biotal treatment plant would not be as much of a concern. Discharge from the treatment plant into a nearby irrigation drain is possible. The community leader did not expect any problems with the discharge to the drain.

2. Location of treatment plant has been changed on the settlement map.

3. Wastewater treatment using Biotal is preferred. Treatment with septic tank/infiltration drain fields may be possible but there are concerns with groundwater that may be only 2 m deep and with availability of sufficient land for infiltration drain fields.

3. Skra Cottage Settlement

Date of Visit: 06.29.2012

Tetra Tech Team: James Gallup, Givi Varduashvili

Existing Situation:

Site visit was made to the settlement location proposed for the wastewater treatment system. Layout of the sewage collection network was considered as well as possible discharge locations. We inspected latrines and discussed drainage systems and cottage mold problems. Observations are provided below:

1. Wooden traditional toilets are in the back of each cottage property, wastes flow into shallow holes in the ground. It did not look like any of the latrines had been pumped out. Latrines are not located where it would be easy to pump out holes.

2. Settlement receives drinking water from a bore-hole. Water is salty. Two common taps are installed to serve 7 households. Water is supplied according to schedule. In summer, there is water for 6 hours; in winter when water is not used for gardens, there is water for 24 hours per day.

3. There is a bath house without toilets. Septic tank and infiltration drainfield installed with bath house.

4. Drainage problems for cottages located in lower areas of settlement.

5. Sewer slope on map with treatment plant location shows slope is good.

6. Mold is a problem in 80 percent of cottages, typically beginning from the ground upward.

7. Land for a treatment plant is available. Discharge would be to an irrigation drain. There is concern about availability of sufficient land for an infiltration drain field. Land for a Biotal treatment plant would not be as much of a concern.

Recommendation:

1. Layout of cottages in settlement allows for gravity sewage collection piping networks that will flow to the treatment plant. There is concern about availability of sufficient land for the infiltration drain field. Land for a Biotal treatment plant would not be as much of a concern. Discharge from the treatment plant into a nearby irrigation drain is possible. The community leader did not expect any problems with the discharge to the drain.

2. Wastewater treatment using Biotal or septic tank/infiltration drain fields is possible. Land is a concern with the infiltration drain fields.

4. Karaleti Cottage Settlement

Date of Visit: 06.29.2012

Tetra Tech Team: James Gallup, Givi Varduashvili

Existing Situation:

Official site visit was not made to the settlement. Settlement discharges to Gori Municipality. No wastewater treatment system is proposed. Observations are provided below:

Existing Situation:

1. Settlement gets drinking water from two bore-holes. Water is salty.

2. There are bathrooms with showers and flush toilets inside cottages. Wastewater is discharged to Gori Municipality.

3. While sewage system is available. It sometimes gets plugged because there are improper slopes in some sewer sections.

5. Berbuki Cottage Settlement

Date of Visit: 07.02.2012

Tetra Tech Team: James Gallup, Givi Varduashvili

Existing Situation:

Site visit was made to the settlement location proposed for the wastewater treatment system. Layout of the sewage collection network was considered as well as possible discharge locations. We inspected latrines and discussed drainage systems and cottage mold problems. Observations are provided below:

1. Wooden traditional toilets are in the back of each cottage property, wastes flow into shallow holes in the ground. Community leader indicated that holes are pumped out every month; most cottages pay for pumping service (15 GEL per hole). We had discussion with septage hauler to confirm that holes were pumped out.

2. Settlement receives drinking water from the bore-hole that operates less than 24 hours per day. Water is not provided inside the cottages, but about 80 percent of cottages have installed water inside cottages on their own. There are common taps installed at the edge of the road.

3. There are two bath houses. It is too expensive to operate as showers, it serves as a clinic. There is a septic tank that discharges to a nearby drain.

4. Community leader indicated that drainage was not a big problem.

5. Sewer slope could be a problem. Settlement is very flat.

6. Mold is a problem in all cottages, typically beginning from the ground upward. Ground water may be about 0.5 m deep. The community leader said the settlement was located in a swampy area.

7. Land for a treatment plant is available. Discharge would be to an irrigation drain. Drain is deep with water in it, it is about 3 km from a small stream.

8. Land is available to install a Biotal treatment plant. The high groundwater table does not allow construction of a septic tank/infiltration drainage system.

Recommendation:

1. Layout of cottages in settlement allows for gravity sewage collection piping networks although the settlement is flat. Land is available and discharge to the nearby irrigation drain is possible. The community leader did not expect any problems with the discharge to the drain.

2. Wastewater treatment using Biotal is preferred. Treatment with septic tank/infiltration drains is not possible because groundwater is only 0.5 m deep.

6. Shavshvebi Cottage Settlement

Date of Visit: 07.02.2012

Tetra Tech Team: James Gallup, Givi Varduashvili

Existing Situation:

Site visit was made to the settlement location proposed for the wastewater treatment system. Layout of the sewage collection network was considered as well as possible discharge locations. We inspected latrines and discussed drainage systems and cottage mold problems. Observations are provided below:

1. Wooden traditional toilets are in the back of each cottage property, wastes flow into shallow holes in the ground. Community leader indicated that holes are pumped out every month; most cottages pay for pumping service (10-15 GEL per hole). We had discussion with septage hauler to confirm that holes were pumped out.

2. Settlement receives drinking water from the bore-hole. There is not sufficient water in summer, there are 28 common taps. A few settlers have installed water inside their cottages (themselves).

3. There are two bath houses. It is too expensive to operate as showers, it serves as a clinic. There is a septic tank that probably discharges to a nearby drain.

4. Community leader indicated that drainage was not a big problem.

5. Sewer slope is good.

6. Mold is a problem in about 90 percent of cottages, typically in kitchens where it is caused by the temperature difference inside and outside the wall. .

7. Land for a treatment plant is available. There is concern about availability of sufficient land for an infiltration drain field. Land for a Biotal treatment plant would not be as much of a concern.

8. Discharge would be to an abandoned irrigation drain. Drain is dry and even with the discharge of treated wastewater, it is unlikely to make it to the stream that is a tributary of the Mtkvari River. It will seep into the drain. Community leader said he would ask neighbors if there is any problem with discharging treated wastewater to the drain.

Recommendation:

1. Layout of cottages in settlement allows for gravity sewage collection piping networks that will flow to the treatment plant. There is concern about availability of sufficient land for the infiltration drain field. Land for a Biotal treatment plant would not be as much of a concern. Discharge from the treatment plant into a nearby irrigation drain is possible. The community leader did not expect any problems with the discharge to the drain.

2. Wastewater treatment using Biotal or septic tank/infiltration drain fields is possible. Land is a concern with the infiltration drain fields.

7. Khurvaleti Cottage Settlement

Date of Visit: 07.02.2012

Tetra Tech Team: James Gallup, Givi Varduashvili

Existing Situation:

Site visit was made to the settlement location proposed for the wastewater treatment system. Layout of the sewage collection network was considered as well as possible discharge locations. We inspected latrines and discussed drainage systems and cottage mold problems. Observations are provided below:

1. Settlement sign reads “Flush Toilets”. These are actually “Pour-Flush Latrines”. Latrines are located in a concrete building using traditional toilets. Water can be poured into opening to drain latrine into a septic tank provided for two cottages. The septic tank is open in the bottom and after 2 years, they have not had to pump it out.

2. The settlement is supplied with water from 50 ton capacity tank that gets water from bore-hole; water is not sufficient and cottages receive water according to a daily schedule. There is separate irrigation water provided.

3. There is a bath house. It is too expensive to operate. There is a septic tank that probably discharges to a nearby drain.

4. Community leader indicated that drainage was a problem.

5. Settlement is nearly flat, sewer slope is not good.

6. Mold is a problem in about 90 percent of cottages. Cottage walls are damp inside. Rain from the west wets cottage walls.

7. Land for a treatment plant is available. There is concern about availability of sufficient land for an infiltration drain field. Land for a Biotal treatment plant would not be as much of a concern.

8. Discharge would be to a small drain that has water in it. The small drain discharges into a nearby larger drain.

Recommendation:

1. Layout of cottages in settlement allows for gravity sewage collection piping networks although the settlement is flat. There is concern about availability of sufficient land for the infiltration drain field. Land for a Biotal treatment plant would not be as much of a concern. Discharge would be to a small drain that has water in it. The small drain discharges into a nearby larger drain.

2. Wastewater treatment using Biotal or septic tank/infiltration drain fields is possible. Land is a concern with the infiltration drain fields.

8. Teliani Cottage Settlement

Date of Visit: 07.03.2012

Tetra Tech Team: James Gallup, Givi Varduashvili

Existing Situation:

Site visit was made to the settlement location proposed for the wastewater treatment system. Layout of the sewage collection network was considered as well as possible discharge locations. We inspected latrines and discussed drainage systems and cottage mold problems. We also visited a riverbed site where the water pipeline from the local village is in the river waterway. Observations are provided below:

1. Wooden traditional toilets are in the back of each cottage property, wastes flow into shallow holes in the ground. Community leader indicated that holes are pumped out every month, most cottages pay for pumping service (10-15 GEL per hole). We had discussion with septage hauler to confirm that holes were pumped out.

2. Settlement receives drinking water from the local village. There is a chlorination building at the entrance to the settlement. The community leader was very concerned that the water pipeline from the village is in the river waterway and may be washed away. Over the past, the river channel has moved and now about 500 m of pipeline is in the river.

3. There is a bath house with flush toilets, but it is not operated. There is a septic tank that probably discharges to a nearby drain.

4. The groundwater table is very high, about 0.7 m.

5. Sewer slope is good.

6. Land for a treatment plant is available. Discharge would be to an irrigation drain.

7. Land is available to install a Biotal treatment plant. The high groundwater table does not allow construction of a septic tank/infiltration drainage system.

Recommendation:

1. Layout of cottages in settlement allows for gravity sewage collection piping networks that will flow to the treatment plant. Sewer slope is good. Land is available and discharge to a nearby drain is possible. The community leader did not expect any problems with the discharge to the drain.

2. Wastewater treatment using Biotal is possible with discharge to a nearby drain.

3. Water pipeline in river channel is a threat to the water supply of the cottage settlement.

9. Metekhi Cottage Settlement

Date of Visit: 07.03.2012

Tetra Tech Team: James Gallup, Givi Varduashvili

Existing Situation:

Site visit was made to the settlement location. We inspected the showers and flush toilets and the existing septic system that discharges to an irrigation drain. We discussed drainage systems and cottage mold problems. Observations are provided below:

1. Cottages have concrete buildings that have showers and flush toilets. They are tiled; they are used; we even saw an electric hair dryer in the bathroom. Typically, there is one 4-part building between each two cottages; part of the building is for two bathrooms and part is for two storage places, one bathroom and one storage area for each cottage.

2. Water from bathrooms is piped to a septic tank that discharges to an irrigation drain. The community leader indicated the sewer worked well, there were no blockages or overflows. Near the septic tank, there is visual signs of septic-tank treated sewage in the drain (and also odor).

3. The settlement is supplied with water from 10 ton capacity tank. Water is good quality but limited quantity. The cottages are on a schedule for receiving water. A few settlers have installed water inside their cottages (themselves).

4. Mold is a problem in all cottages. Cottage walls are damp, beginning from the ground upward.

Recommendation:

1. Wastewater treatment using only a septic tank is inadequate.

10. Tsilkani Cottage Settlement

Date of Visit: 06.28.2012

Tetra Tech Team: James Gallup, Givi Varduashvili

Existing Situation:

Site visit was made to the settlement location proposed for the wastewater treatment system. Layout of the sewage collection network was considered as well as possible discharge locations. We inspected latrines and discussed drainage systems and cottage mold problems. Observations are provided below:

1. Wooden traditional toilets are in the back of each cottage property, wastes flow into shallow holes in the ground. It did not look like any of the latrines had been pumped out.

2. Settlement receives drinking water for about 4 hours per day. It is possible that people drill the water pipe for irrigation outside the settlement resulting in a shortage of drinking water. Cottages receive separate irrigation water most of the time. Cottages do not have water inside, taps are arranged in the yards.

3. Community leader indicated that drainage was a big problem. There was flooding and the drainage channels needed cleaning.

4. Settlement is nearly flat, sewer slope is not good. .

5. Mold is a problem in about 70 percent of cottages, typically from leaking roofs.

6. Land for a treatment plant is available. There is concern about availability of sufficient land for an infiltration drain field. Land for a Biotal treatment plant would not be as much of a concern.

7. Discharge would be to a nearby ditch that discharges into a larger drain.

Recommendation:

1. Layout of cottages in settlement allows for gravity sewage collection piping networks although the settlement is flat. There is concern about availability of sufficient land for the infiltration drain field. Land for a Biotal treatment plant would not be as much of a concern. Discharge would be to a nearby ditch that discharges into a larger drain.

2. Wastewater treatment using Biotal or septic tank/infiltration drain fields is possible. Land is a concern with the infiltration drain fields.

11. Frezeti Cottage Settlement

Date of Visit: 06.28.2012

Tetra Tech Team: James Gallup, Givi Varduashvili

Existing Situation:

Site visit was made to the settlement location proposed for the wastewater treatment system. Layout of the sewage collection network was considered as well as possible discharge locations. We inspected latrines and discussed drainage systems and cottage mold problems. Observations are provided below:

1. Wooden traditional toilets are in the back of each cottage property, wastes flow into shallow holes in the ground. It did not look like any of the latrines had been pumped out.

2. Settlement receives drinking water for about 30 minutes in the morning and 30 minutes in the evening.

3. Settlement is on top of hill and the slope for about 200 cottages descends in one direction and the slope of about 100 cottages moves in the opposite direction. There are 5-6 cottages located beyond a hill that slopes away from both other directions.

4.   Mold is a problem in about 80 percent of cottages, typically on the walls facing north that face rain and wind.

5.   Land for two treatment plants is available. Separate plants are needed because of the different slopes in the settlement. Land is available, but there is concern about availability of sufficient land for an infiltration drain field at each location. Land for a Biotal treatment plant would not be as much of a concern.

6. Discharge from each treatment site would be to a nearby ditch that flows downhill to a stream or river.

Recommendation:

1.   Layout of cottages in settlement allows for gravity sewage collection piping networks although the different slope will require two separate treatment plant. There are also 5-6 cottages that may need separate treatment.

2.   There is concern about availability of sufficient land for the infiltration drain field at each treatment location. Land for two Biotal treatment plants would not be as much of a concern. Discharge from each treatment site would be to a nearby ditch that flows downhill to a stream or river.

12. Tserovani Cottage Settlement

Date of Visit: 06.29.2012

Tetra Tech Team: James Gallup, Givi Varduashvi

Existing Situation:

Site visit was made to the activated sludge wastewater treatment system at this settlement. Observations are provided below:

Existing Situation:

1.   Cottages have bathrooms that are connected to a sewer system and an activated sludge wastewater treatment system.

2.   The treatment system has low levels of sludge production, the system has not generated sufficient sludge levels for proper treatment of for sludge recycling to the aeration basin or sludge wasting. There is sludge dewatering equipment that has never been operated.

3. The Tserovani treatment system is complex, difficult to operate and not well designed for cottage settlements where sewage flow is highly variable and operators not well trained. Biotal is a special type of activated sludge that is designed for treatment of sewage from small local communities like IDP cottage settlements. Biotal provides five sewage processing modes that automatically switch operation of the treatment plant during periods of wide variations of sewage inflow, including levels higher or lower than the design loading. At

higher loadings, the plant moves into an accelerated sludge growth and wastewater treatment mode. At low and very low loading levels, the plant automatically switches into a slow growth level after 1 hour, an even slower level after 24 hours of low loadings and a low sustained stabilization level after 7 days. The plant is able to maintain living microorganisms and an active sludge during long absences of sewage. It is able to move into higher microorganism growth rates and higher treatment levels as sewage levels return to normal levels.

13. Sakasheti Cottage Settlement

Date of Visit: 07.03.2012

Tetra Tech Team: James Gallup, Givi Varduashvili

Existing Situation:

Site visit was made to the settlement location. We inspected the showers/toilets and the existing septic system. We discussed drainage systems and cottage mold problems. Observations are provided below:

1. Bathrooms, toilets and water taps are inside cottages. All wastewater flows into a sump next to the cottage and then into a concrete holding tank. The four cubic meter tank is divided into two parts to receive waste separately from each of the two cottages and it is open in the bottom. The tank fills and needs to be pumped out by a septage hauler every 3 – 5 days. We had discussion with septage hauler to confirm that holes were pumped out. He was pleased that the tank was easy to access with his truck and that it needed to be pumped out frequently.

2. The settlement is supplied with water from a bore-hole and they have a 50 ton capacity tank.

3. Community leader indicated there was a drainage problem. Cottages in the lower part of the settlement experience flooding.

4. Community leader indicated that mold was not a problem in the settlement.

5. Sewer slope is good.

6. Land for a treatment plant is available. There is concern about availability of sufficient land for an infiltration drain field. Land for a Biotal treatment plant would not be as much of a concern.

7. Discharge would be to a nearby irrigation ditch.

Recommendation:

1. The need to frequently pump out the holding tank is a problem.

2. Layout of cottages in settlement allows for gravity sewage collection piping networks that will flow to the treatment plant. There is concern about availability of sufficient land for the infiltration drain field. Land for a Biotal treatment plant would not be as much of a concern. Discharge from the treatment plant into a nearby irrigation ditch is possible.

2. Wastewater treatment using Biotal or septic tank/infiltration drain fields is possible. Land is a concern with the infiltration drain fields.

14. Verkhvebi Cottage Settlement

Date of Visit: 07.02.2012

Tetra Tech Team: James Gallup, Givi Varduashvili

Existing Situation:

Official site visit was not made to the settlement. Settlement discharges to Gori Municipality. No wastewater treatment system is proposed. Observations are provided below:

1. Settlement gets drinking water from Gori water supply. Settlement has 240 ton capacity water tank.

2. There are bathrooms with showers and flush toilets inside cottages. Wastewater is discharged to Gori Municipality.

3. Many cottages have cracked walls in their buildings.

4. Wastewater Treatment Technologies

Five sewage treatment technologies were identified for evaluation and assessment in the Programmatic Environmental Assessment (PEA) for IDP Cottage Settlements. Two additional technologies were considered but it was determined that additional study was not needed in the PEA. Later, two other treatment technologies used in Georgia were considered.

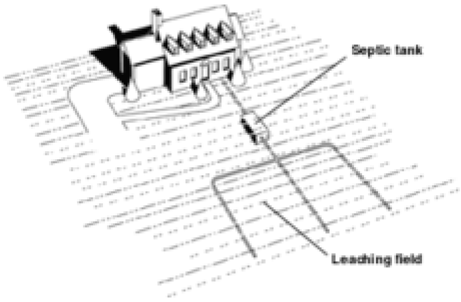
The following nine sewage treatment technologies are considered in this assessment:

- Septic Tank and Infiltration Drain Field Treatment
- Oxidation Ponds Wastewater Treatment
- Aerated Lagoon Biological Treatment
- Dry Toilets
- Activated Sludge Biological Treatment
- Constructed Wetlands
- Rotating Biological Contactors
- Biotal Biological Treatment
- Georgian Septic Tanks

The descriptions below provide an analysis of the first part of treatment technologies considered for IDP cottage settlements. Each technology was evaluated for suitability and sustainability of treatment at settlements.

Septic Tank and Infiltration Drain Field Treatment. This treatment system involves an enclosed septic tank and an infiltration drain field to disperse the effluent from the septic tank, reducing the risk of overloading any one place in the drain field. The septic tank provides primary treatment of the sewage, removing most of the settleable solids, greases, and floatable matter. Anaerobic liquefaction of the solids occurs in the tank. The overflow of liquid sewage is discharged throughout a subsurface infiltration system where soil provides sewage treatment. A biomat forms at the infiltration surface and the soil beneath this surface provides aerobic physical, chemical, and biological treatment as the sewage migrates to groundwater. Systems are designed with hydraulic and mass loadings and geometric distribution methods to ensure treatment takes place in the upper reaches of the soil and clean water is discharged to groundwater. Cleaning of septic tank solids is typically needed once or twice per year. The septic tank may be one central tank located near the drain field or many smaller septic tanks can be installed, typically one tank for every two cottages. The central septic tank is less expensive to install compared to separate tanks at cottages. The septic tank and infiltration drain field treatment system is most appropriate for smaller cottage settlements that do not have shallow groundwater tables.

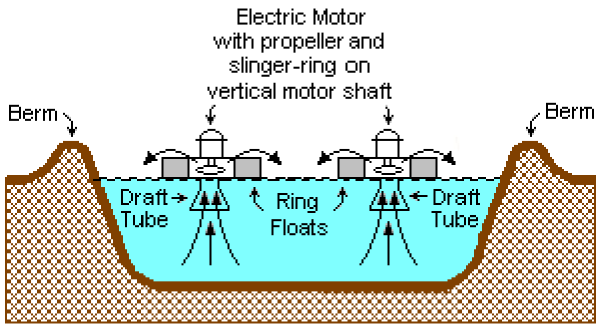
The septic system is depicted below:



Septic Tank and Infiltration Drain Field

Oxidation Ponds. Oxidation ponds (OPs) are an inexpensive wastewater treatment technology for sites that have sufficient land and site-specific conditions permitting large, deep lagoons. OPs are also known as stabilization ponds or lagoons. They are used for simple secondary treatment (85% removal of sewage pollution as measured as biochemical oxygen demand). Bacteria in the ponds degrade organic matter in the sewage producing cellular material and minerals that support the growth of algae and other organisms. Growth of algae allows further decomposition of the organic matter by producing oxygen. The production of this oxygen replenishes the oxygen used by the bacteria. OPs are usually deep, often over three meters deep so that they can support needed algal growth. OPs need to be even deeper in cold climates because they are strongly influenced by seasonal temperature changes and they tend to fill, due to the settling of the bacterial and algal cells formed during the decomposition of the sewage. The OP treatment processes are slow, thus requiring large holding capacities and retention times of one month or more. This technology is most appropriate to IDP cottage settlements with large areas of available land where the groundwater table is relatively deep.

Aerated Lagoon Biological Treatment. Aerated lagoons are pond-like bodies of water or basins designed to receive, hold, and treat wastewater for a predetermined period of time. Lagoons can be lined with material, such as clay or an artificial liner, to prevent leaks to the groundwater below. Diffused aeration or motor driven, mechanical aerators provide a combination of liquid aeration and mixing. Diffused aeration involves injection of air under pressure below the liquid surface, bubbled through diffusers on the bottom of the lagoon. Mechanical aerators produce a gas - liquid interface by entraining air from the atmosphere and dispersing it into bubbles. Both diffused air and mechanical aerators provide air required by the biological oxidation reactions in the basins, and they provide the mixing required for dispersing the air and for contacting the reactants (that is, oxygen, wastewater and microbes). Basins are constructed in, or on the ground surface, using earthen dikes to retain the wastewater within which natural stabilization processes occur with the necessary oxygen coming from the mechanical aerators or atmospheric diffusion. A typical aerated lagoon is depicted below.



A TYPICAL SURFACE – AERATED BASIN

Note: The ring floats are tethered to posts on the berms.

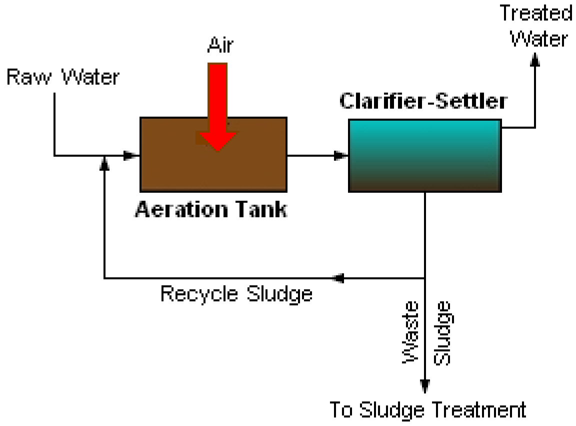
Treated effluent from aerated lagoons is normally disinfected with chlorine and discharged to streams/rivers. Aerated lagoons may use diffused aeration or floating surface aerators and they typically should achieve 85% removal of sewage pollution as measured as biochemical oxygen demand. Lagoon retention times of 1 to 10 days are needed and ponds are typically 1.5 meters deep. Aerated lagoons are sensitive to temperature and operate best between 0 °C and 40 °C. At colder temperatures, the rate of biological reactions slow and retention time may need to be extended.

Dry Toilets. Several types of new toilet systems are possible components. Composting toilets, dry toilets, and the Enviro Loo dry toilet are considered as alternatives to constructing wastewater collection networks and sewage treatment plants at each cottage. A dry toilet removes human waste without a water discharge. Liquid and solid wastes are separated. Aerobic processes or composting treats the waste. Bacteria at elevated temperature break down the waste or materials are added for composting. Dry toilets may also use air to dehydrate the solid waste and evaporate liquid waste. A variety of dry toilets are available. They are not a pit in the ground, they are a sound environmental alternative to constructing wastewater collection networks and sewage treatment plants in each settlement.

Activated Sludge Biological Treatment. The activated sludge wastewater treatment process involves air introduced into a mixture of screened sewage combined with organisms to develop biological particles which reduce the organic content of the sewage. This biological material is largely composed of bacteria and the combination of wastewater and biological mass is commonly known as mixed liquor. In all activated sludge plants, once the wastewater has received sufficient treatment, excess mixed liquor is discharged into settling tanks and the treated effluent is discharged after chlorination.

Part of the settled material, the sludge, is returned to the head of the aeration system to re-seed the new wastewater entering the tank. This fraction of the biological particles is called return activated sludge. Excess sludge--waste activated sludge--is removed from the treatment process to keep the ratio of biomass to food supplied in the wastewater in balance. The excess sludge is stored in sludge tanks and is further treated by digestion, either under anaerobic or aerobic conditions prior to disposal.

In this method, treated effluent from the activated sludge treatment plant is disinfected with chlorine and discharged to streams/rivers. The activated sludge treatment system is depicted below:



The following parts describe two additional technologies, Constructed Wetlands (CW) and Rotating Biological Contactors (RBCs). The rationale for the assessment that these technologies are not appropriate for IDP cottage settlements is provided below.

Constructed Wetlands. CWs use wetland plants in a constructed wetland environment to treat sewage. They can be designed as surface flow, subsurface flow, horizontal, or vertical flow. CWs provide a high degree of biological improvement and depending on design, act as a primary, secondary, and sometimes tertiary treatment. They are highly productive systems as they copy natural wetlands and their fundamental recycling capacity of the hydrological cycle in the biosphere. However, CWs were not included as a viable alternative for IDP cottages because they have not been used in Georgia and require specific skills unavailable in the country. They also require large amounts of land.

Rotating Biological Contactors. RBCs are mechanical secondary treatment systems, robust and capable of withstanding surges in organic load. They use rotating disks to support the growth of bacteria and microorganisms present in the sewage, treating the organic pollutants. Microorganisms on the RBCs need oxygen to live and food to grow. Oxygen is obtained from the atmosphere as the disks rotate. As the microorganisms grow, they build up on the media until they are sloughed off due to shear forces provided by the rotating discs in the sewage. Effluent from the RBC is then passed through final clarifiers where the microorganisms in suspension settle as sludge. The sludge is withdrawn from the clarifier for further treatment or disposal. RBCs are not included as a viable alternative for treatment of IDP cottage settlements because their use in Georgia is very limited, they are complex and very expensive.

Other technologies Currently used in Georgia

Additional evaluation and review was provided on sewage treatment technologies currently used in Georgia. Biotal and various forms of septic tank treatment were considered. Biotal is a new technology based on activated sludge treatment. Biotal is currently used to treat sewage from Saguramo and Zugdidi IDP buildings as well as at hotels, gas stations and hospitals. Conventional activated sludge is used at Tserovani Settlement and it has low levels of sludge production. The Tserovani system has not generated sufficient sludge levels for proper treatment of for sludge recycling to the aeration basin or sludge wasting. There is sludge dewatering equipment that has never been operated. The Tserovani activated sludge treatment system is complex, difficult to operate and not well designed for cottage settlements where sewage flow is highly variable and operators not well trained.

Biotal Biological Wastewater Treatment. Biotal is a special type of activated sludge that is designed for treatment of sewage from small local communities like IDP cottage settlements. Biotal provides five sewage processing modes that automatically switch operation of the treatment plant during periods of wide variations of sewage inflow, including levels higher or lower than the design loading. At higher loadings, the plant moves into an accelerated sludge growth and wastewater treatment mode. At low and very low loading levels, the plant automatically switches into a slow growth level after 1 hour, an even slower level after 24 hours of low loadings and a low sustained stabilization level after 7 days. The plant is able to maintain living microorganisms and an active sludge during long absences of sewage. It is able to move into higher microorganism growth rates and higher treatment levels as sewage levels return to normal levels. Additional information is provided on Biotal later in this section and in Annex B and Annex C.

Biotal was designed to take advantage of the significant advantages of both continuous and discontinuous biological treatment systems and to avoid their disadvantages. Biotal utilizes new patented technologies including the siphon airlift, regulated siphon and the regulated airlift and reverse airlift. Also, new technologic systems were used including the accepting container - denitrificator (ACD), 3-stage reactor sequencing batch reactor (SBR), and Biofilter-Thin-Layered sedimentation (BFTL). These system parts were selected because of their reliability. There are no moving parts and devices are made with magnetic valves that deliver air under one of six modes. In addition, Biotal is switched automatically by the MITSUBISHI controller based on the quantity of incoming sewage. The magnetic valves, ASCO (Netherlands), have strong capability, being able to switch millions of cycles. The automation of Biotal is made with modules of leading manufacturers - Mitsubishi, Moeller and others.

Biotal provides effective biological treatment with its fully automatized 6-stage and 3-sludge processing using self-regulated hydro-pneumo-biological processes with 4-planimetric recirculation of returnable active sludge. Biotal operates under a wide system dynamic that includes organic substances, nitrogen and phosphorous around 100:5:1. While these ratios do not occur all the time, Biotal allows bacteria of active sludge to leave what they haven't eaten; meaning that the multiplanimetric sludge recirculation and the multistage operating system makes these reactants to circulate together with the active sludge and the organisms are ready for new sewage where the incoming reactants may differ widely over time.

Biotal automatically switches into one of 6 programs: forced mode (when the quantity of sewage is more than the project one). With the absence of sewage into the plant, Biotal automatically passes in the first (in 1 hour), the second (in 24 hours) and into the third (in 168 hours) economical modes. It allows for reducing the need for electric power to prolong the service life of equipment and to provide for long live of the microorganisms of active sludge. For instance, when the sewage is absent for more than 7 days, the system passes into the third economic mode which saves up to 80% of energy as well as the long life of compressors and valves.

Figure 1 below provides a technological scheme of Biotal plants that operate between 10 cubic meters and 1,000 cubic meters per day.

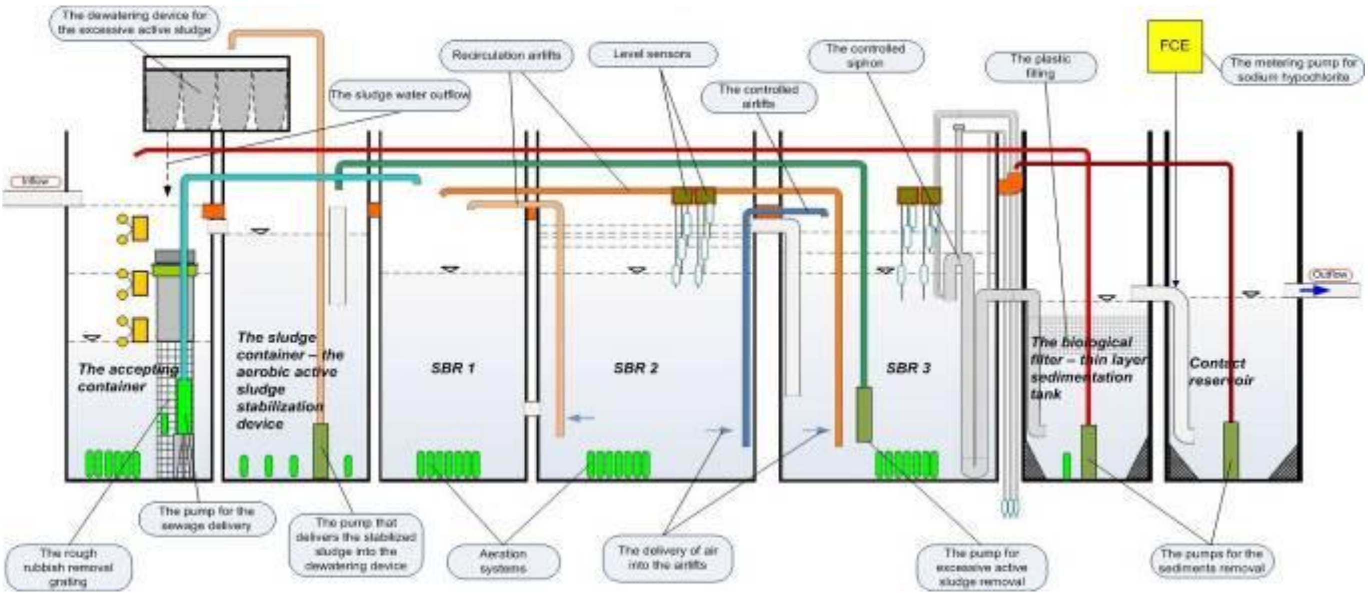


Figure 1: Biotal Technological Scheme

Biotal operates in eight zones of sewage processing: 1) Trash bar-screen grate; 2) Accepting Container-Dentirificator (ACD); 3) First stage SBR reactor; 4) Second stage SBR reactor; 5) Third stage SBR reactor; 6) Aerated Biological Filter; 7) Thin-Layer Sedimentation tank; and 8) Contact Reservoir. There are also two zones of surplus active sludge processing: 9) Aerobic Active Sludge Stabilizer; and 10) Dewatering Module.

Biotal is a technology appropriate for IDP cottage settlements. It is much simpler than conventional activated sludge treatment. A trained operator is not required and Biotal has many automatic settings that do not require the presence of an operator. Biotal can operate under many different conditions of sewage inflow, from high loadings to no sewage inflow for extended periods. Biotal is designed for the type of conditions typical of small communities and IDP cottage settlements. It provides exemplary sewage treatment when other systems would develop problems and fail. The standard automatic programs of Biotal plants are made for household sewage applications like IDP cottage settlements.

Georgian Septic Tanks. Various types of septic treatment systems are also used in Georgia. A septic tank that discharges to an drainage channel is used at Metekhi Settlement and septic collection pits are used at Sakhasheti settlement. There are concerns with this technology. The treated discharge at Metekhi still has organic pollutants and there are odor/visual signs of pollution in the drainage channel. The Sakhasheti system provides little treatment and must be pumped every few days.

5. Recommended Treatment Technologies

Technical, economic, environmental and social effects of different treatment technologies are discussed below. Comparisons are provided for three forms of biological treatment, Biotal, aerated lagoons and activated sludge, as well as comparisons between Biotal and septic tank and infiltration drain field treatment and dry toilets like Enviro Loo.

BIOLOGICAL TREATMENT TECHNOLOGIES

Aerated lagoons, activated sludge and Biotal biological treatment use external mechanical or diffuse air for aeration and mixing of microorganisms that eat the sewage and remove the organic pollution. Biotal is constructed as a single unit with multiple compartments that operate automatically. Aerated lagoons are typically constructed as one or more earthen ponds and activated sludge is constructed in separate tanks or concrete basins. While they are similar in that they each provide biological treatment of sewage to low levels, there are important differences in their implementation at IDP cottage settlements in Georgia.

- Aerated lagoons are relatively simple, they are inexpensive, require little operator attention and low levels of maintenance. The system is turned on and typically left on for long periods. The only O&M cost is the electricity for mechanical or diffuse aeration and chlorination.

- Activated sludge involves primary clarification to remove solids, aeration and mixing for removal or organic pollutants and final clarification to separate the biological solids. It requires operator attention to maintaining solids levels in the aeration basin and returning and wasting proper amounts of sludge. It is subject to upset and may be difficult to re-establish the proper mixture of microorganisms.

- Biotal is a form of activated sludge. It is much simpler than conventional activated sludge treatment. A trained operator is not required and Biotal has many automatic settings that do not require the presence of an operator. Biotal can operate under many different conditions of sewage inflow, from high loadings to no sewage inflow for extended periods. Biotal is designed for the type of conditions typical of small communities and IDP cottage settlements. It provides exemplary sewage treatment when other systems would develop problems and fail. The standard automatic programs of Biotal plants are made for household sewage applications like IDP cottage settlements.

Biotal has many advantages compared to aerated lagoons or conventional activated sludge treatment. Biotal requires much less land than aerated lagoons and it has been used in many applications in Georgia, including IDP housing. Biotal is much less complex than activated sludge. Biotal maintains treatment performance better than activated sludge under high or low sewage inflows and loadings. Biotal does not require trained operators and it is less expensive.

SEPTIC TANK AND INFILTRATION DRAIN FIELD TREATMENT

Septic Tank and Infiltration Drain Field Treatment involves a multiple septic tanks or a central tank for solids removal and an infiltration drain field that utilizes the soil for sewage treatment. It provides environmental benefits in terms of no discharge to receiving rivers/streams but there is some residual pollution that may move through the soil drain field and into groundwater. There is a substantial requirement for land. Also, children and IDPs may come into to contact with sewage in the drain field. This technology provides effective treatment at low cost, but may be limited to smaller applications.

DRY TOILETS

Composting toilets are an alternative to constructing wastewater collection networks and sewage treatment plants. The toilets remove human waste without a liquid discharge. They require some O&M to prevent noxious odors and potential contamination of the surrounding area. Composting toilets are moderately expensive but their total cost is much less than a wastewater collection network and sewage treatment. For Enviro Loo dry toilets, preventive maintenance may be an issue for some IDPs (e.g., checking the liquid level below the drying plate under the toilet, ensuring the liquid and solid waste are separate and allow for aerobic operations and expecting owners to rake solid waste from under the pan section toward the open rear-end). Demonstrations are needed to prove acceptability and training may be needed to keep these toilets operating effectively. These toilet systems have significant environmental benefits and they eliminate the need for land needed for a sewage treatment plant.

WASTEWATER TREATMENT REQUIREMENTS

Table 1 provides the wastewater treatment requirements for the World Bank, European Union and Georgia. These effluent standards apply to strong sewage, medium and low strength sewage. The Georgian Order N 745 standards apply to IDP cottage settlements.

The biological treatment technologies discussed above (aerated lagoons, activated sludge and Biotal biological treatment), septic tank and infiltration drain field treatment and dry toilets all comply with these requirements.

Table 1. Wastewater Treatment Requirements

Parameter	Strong Sewage	Medium Sewage	Low Sewage	World Bank Guidelines	Europe Union 2000-10,000 pop equivalent	Europe Union > 10,000 pop equivalent	Georgia Order N 745 13.11.2008
BOD_5 (mg/l) Biochemical oxygen demand	350	250	150	50	25 70-90% reduction	25 70-90% reduction	25
COD (mg/l) Chemical oxygen demand	740	530	320	250	125 70% reduction	125 70% reduction	125

TSS (mg/l) Total suspended solids	450	300	190	50	35 90% reduction	35 90% reduction	60
Total P Phosphorous (mg/l)	23	16	10	2	--	2.0 80% reduction	2.0
Total N Nitrogen (mg/l)	80	50	30	10 (ammonia)	--	15 70-80% reduction	15

WASTEWATER TREATMENT DESIGN CAPACITY

Table 2 provides the average water consumption for IDP settlers based on the internal sanitary-technical equipment installed in cottages and apartment buildings

Table 2: Water Consumption in Georgia

Water consumers	Average daily (per year) household water use in settled areas per person, l/day
Individual or apartment buildings: With sanitation without bathtubs	 90-120
With gas supply	115-150
With sanitation and bathtubs with water heaters which operates on solid fuel	140-180
With sanitation and bathrooms with gas heaters	170-190
With accelerated gas heaters with multipoint water pumping	190-250
Note: Smaller rates used for cottages, larger rates for apartment buildings with common water supply systems	

Table 3 provides wastewater design flows for each cottage settlement. The 50 l/day design value applies to toilet wastes and the 200 l/day value applies to total wastewater usage per cottage.

Table 3. Cottage Wastewater Treatment Design

item	Settlement	Cottage	HH	Indiv.	Design Flow (l/da/per)	Design Flow (m≥/da)	Design Flow (l/da/per)	Design Flow (m^3/da)
1	Akhalsopeli	100	100	350	50	18	200	70
2	Mokhisi	58	58	220	50	11	200	44
3	Skra	86	86	312	50	16	200	62
4	Berbuki	134	134	460	50	23	200	92
5	Shavshvebi	177	177	586	50	29	200	117
6	Khurvaleti	139	139	460	50	23	200	92
7	Teliani	54	54	164	50	8	200	33
8	Tsilkani	400	399	1093	50	55	200	219
9	Frezeti	300	263	721	50	36	200	144
Total/Avg		1448	1410	4366				

CAPITAL COSTS OF TREATMENT TECHNOLOGIES

The capital installation cost of Infiltration with a single septic tank, Infiltration with septic tanks at each cottage, Biotal biological treatment and aerated lagoons is shown in Table 4. The cost of septic systems and lagoons do not include costs for land and septic tank costs are based on treatment of toilet waste only (i.e., showers and other grey wastewaters are disposed of separately). The cost of activated sludge is not included in the table because it is more expensive than Biotal or aerated lagoons and it has many operating disadvantages as discussed previously. Dry toilets are not included in this table; their cost is about $2,000 each plus shipping and installation.

Table 4 shows that aerated lagoon sewage treatment is the least cost alternative among treatment systems. Central Septic Tanks with Infiltration Drain Fields is the significantly less expensive than septic tanks at each cottage. Septic tanks, Biotal and aerated lagoons all require sewer networks, so their total cost is the cost of treatment plus the cost of the sewer network.

For the Akhalsopeli IDP cottage settlement, the lowest cost alternative is aerated lagoons with a capital cost of $67,500 (including sewer network and treatment system). The cost of Biotal is almost $101,000 and the cost of septic tanks ranges from $88,000 with a central tank to $125,000 with septic tanks at each cottage. The cost for Enviro Loo dry toilets would be about $200,000. Economic feasibility in Table 2 includes consideration of these costs.

Table 4: Cottage Settlement Wastewater Treatment Cost (Capital Cost, USD)

	Location	Sewer Network	Infiltration with single septic tank	Infiltration with septic tanks at each cottage	Biotal Biological Treatment	Aerated Lagoons
1	Akhalsopeli	28,099	60,205	97,027	72,788	39,394
2	Mokhisi	37,554	10,946	29,350	50,120	39,394
3	Skra	34,201	28,200	53,942	72,788	39,394
4	Berbuki	57,875	No	No	85,773	59,091
5	Shavshvebi	62,917	46,159	102,494	99,316	78,788
6	Khurvaleti	44,979	83,770	133,642	85,773	59,091
7	Teliani	38,226	No	No	50,120	39,394
8	Tsilkani	207,911	119,772	243,185	225,826	78,788
9	Frezeti	189,164	177,667	288,320	158,671	78,788
	Total	**700,926**	**526,719**	**947,960**	**901,175**	**512,122**

Table 5 compares the impacts of different sewage treatment technologies in comparative form with the intention of sharpening the positives/negatives and providing a clear basis for selection of a recommended technology for IDP cottage settlements. Technical feasibility includes how appropriate the technology is for IDP cottage settlements in Georgia and economic feasibility includes consideration of capital costs requirements. Technical feasibility includes assessment during construction as well as during the operation phase of project implementation. The land use factor includes the requirement for land, land disturbance and the amount of land converted to a different use. Environmental considerations include separate ratings for positive or negative effects on soil resources, groundwater and surface water resources. Human health effects are rated separately, as is socio-cultural acceptance. The technology's operation and maintenance (O&M) requirements is assessed last in the table.

The ratings range from a highly positive effect/beneficial (+2) to a significant negative effect/highly detrimental (-2). The rating "0" means there is no effect or there is the same rate of change versus getting progressively better or worse. The "C" is for the construction phase of the project implementation and "O" is for the operation phase. O&M only applies to the operation phase.

Table 5: Comparison of Environmental Impacts of Sewage Treatment Alternatives

(+2) highly positive effect/beneficial; (+1) positive/beneficial; (-2) significant negative effect/highly detrimental; (-1) negative effect/detrimental; (0) remains the same (i.e., no effect or same rate of change versus gets progressively worse or better) C=Construction phase; O=Operation phase

Potential Feasibility Issues and Considerations	Septic Tank-Infiltration Drain Fields		Oxidation Ponds		Aerated Lagoon Biological Treatment		Dry Toilets		Activated Sludge Biological Treatment		Biotal Biological Treatment	
	C	O	C	O	C	O	C	O	C	O	C	O
Technical Feasibility	0	+2	0	-1	0	-1	0	+1	-1	-2	+1	+1
Economic Feasibility	0	+1	0	+1	0	0	-1	0	-1	-2	0	-1
Land Use (amount of land converted to a different use)	0	-2	0	-2	0	-1	0	0	0	+1	0	+1
Soil Resources (disturbance)	0	-1	0	-1	0	0	0	0	0	0	0	0
Groundwater Resources	0	-1	0	-1	0	-1	0	0	0	0	0	0
Surface Water Resources	0	0	0	+1	0	+1	0	0	0	-1	0	+2
Human Health	0	+1	0	+1	0	+1	0	+1	0	-1	0	+1
Socio-Cultural Acceptance	0	0	-1	-2	-1	-1	0	-1	0	0	0	+1
O & M		0		0		-1		-1		-2		0

The next several sections compare technologies, Biotal vs Septic Tanks, Biotal vs Dry Toilets, Biotal vs Activated Sludge, and Biotal vs Aerated Lagoons. After these comparisons, site-specific local conditions will be described for each settlement. These findings and the ratings in Table 5 will be used to determine the treatment technology recommended for each settlement. Comparisons of cottage treatment technologies are provided below.

Biotal vs Septic Tanks

Biotal is also better when compared to septic tanks and infiltration drain fields. Septic tanks are better when compared on economic feasibility. Septic tanks are not as good as Biotal when rated on land requirements, land use and land disturbance. Biotal is better than Septic tanks on groundwater impacts and these technologies are about the same on O&M and both technologies are rated high on human health considerations. Biotal is considered more socially accepted and septic tanks have a slightly higher rating on technical feasibility.

Biotal vs Dry Toilets

When Biotal is compared to dry toilets like Enviro Loo, dry toilets are slightly better on technical feasibility. Biotal has higher O&M costs and Enviro Loo has higher capital/construction costs. Both are good on land use, although Biotal is slightly better. They are about the same on soil and groundwater impacts and human health considerations. For surface water, Biotal is better. For O&M, Biotal is better; maintenance may be a problem for IDPs servicing dry toilets. Biotal is also better on social acceptability. It is not known whether IDPs will accept dry toilets.

Biotal vs Activated Sludge

Biotal has many advantages compared to conventional activated sludge treatment. The technical feasibility of Biotal is better and Biotal is rated much better on surface water considerations. Biotal is also much better on O&M and somewhat better on human health concerns. Biotal is slightly better than activated sludge on economic feasibility and both Biotal and activated sludge are about the same on land use and land disturbance, and soil disturbance and groundwater considerations.

Biotal vs Aerated Lagoons

Biotal, because it is used now in Georgia, is higher on technical feasibility when compared to aerated lagoons. Aerated lagoons are less complex than Biotal but lagoons are not used in Georgia. Aerated lagoons are cheaper to install and better economic feasibility. Biotal is better on land use and land disturbance. They are about the same on surface water and groundwater impacts, and human health considerations. The socio-cultural acceptance of Biotal is better than aerated lagoons because Biotal is demonstrated at about 80 sites in Georgia.

TREATMENT TECHNOLOGY RECOMMENDATIONS

Recommendations for each IDP cottage settlement are based largely on the site-specific local conditions at each settlement. These local conditions are discussed below for each settlement and these findings determine the treatment technology most appropriate for each settlement. The individual descriptions of the local settlement conditions are provided as follows:

Akhalsopeli IDP Cottage Settlement. This settlement has 100 cottages and 350 residents. The current latrines will be replaced with water supplied inside cottages and new buildings with showers and flush toilets. With water usage at 200 liters/person/day, the design flow for the treatment plant at Akhalsopeli is expected to be 70 m^3/day. All sewage and wastewater will be piped into sewer systems that will transport wastewaters to the treatment plant. The map of the sewer network in the settlement and the location of the treatment plant are included in Annex A. Sewage will flow by gravity through the sewer pipeline to the treatment plant. The slope of the settlement is good for gravity flow. The community leader indicated that land is available for the treatment plant and that discharge to the nearby irrigation drain should not be an issue with neighbors. Biotal is the first choice recommendation for this settlement and a central septic tank and infiltration drain field is recommended second. Municipalities have indicated that sufficient land is not available for drain fields, and if this is the local situation here, then dry toilets like Enviro Loo may need to be considered if Biotal is not possible. But Biotal is the first choice recommendation.

Mokhisi IDP Cottage Settlement. This settlement has 58 cottages and 220 residents. The current latrines will be replaced with water supplied inside cottages and new buildings with showers and flush toilets. With water usage at 200 liters/person/day, the design flow for the treatment plant at Mokhisi is expected to be 44 m^3/day. All sewage and wastewater will be piped into sewer systems that will transport wastewaters to the treatment plant. The map of the sewer network in the settlement and the location of the treatment plant are included in Annex A. Sewage will flow by gravity through the sewer pipeline to the treatment plant. The slope of the settlement is good for gravity flow. The community leader indicated that land is available for the treatment plant and that discharge to the nearby irrigation drain should not be an issue with neighbors. Biotal is the first choice recommendation for this settlement. The community leader indicated that the local groundwater table may only be 2 m deep and thus, if tests verify this level, then dry toilets would be recommended second. Groundwater at this level would not allow construction of a central septic tank and infiltration drain field. Biotal is the first choice recommendation and dry toilets like Enviro Loo are recommended second.

Skra IDP Cottage Settlement. This settlement has 86 cottages and 312 residents. The current latrines will be replaced with water supplied inside cottages and new buildings with showers and flush toilets. With water usage at 200 liters/person/day, the design flow for the treatment plant at Skra is expected to be 62 m^3/day. All sewage and wastewater will be piped into sewer systems that will transport wastewaters to the treatment plant. The map of the sewer network in the settlement and the location of the treatment plant are included in Annex A. Sewage will flow by gravity through the sewer pipeline to the treatment plant. Sewage will flow by gravity through the sewer pipeline to the treatment plant. The slope of the settlement is good for gravity flow. The community leader indicated that land is available for the treatment plant and that discharge to the nearby irrigation drain should not be an issue with neighbors. Biotal is the first choice recommendation for this settlement and a central septic tank and infiltration drain field is recommended second. Municipalities have indicated that sufficient land is not available for drain fields, and if this is the local situation here, then dry toilets like Enviro Loo may need to be considered if Biotal is not possible. But Biotal is the first choice recommendation.

Berbuki IDP Cottage Settlement. This settlement has 134 cottages and 460 residents. The current latrines will be replaced with water supplied inside cottages and new buildings with showers and flush toilets. With water usage at 200 liters/person/day, the design flow for the treatment plant at Berbuki is expected to be 92 m^3/day. All sewage and wastewater will be piped into sewer systems that will transport wastewaters to the treatment plant. The map of the sewer network in the settlement and the location of the treatment plant are included in Annex A. Sewage will flow by gravity through the sewer pipeline to the treatment plant. The slope of the settlement is nearly flat so special attention will be needed to insure that sewage flows properly to the treatment plant. The community leader indicated that land is available for the treatment plant and that discharge to the nearby irrigation drain should not be an issue with neighbors. Biotal is the first choice recommendation for this settlement. The groundwater table is only 0.5 m deep, so a central septic tank and infiltration drain field is not possible. Biotal is the first choice recommendation and dry toilets like Enviro Loo are recommended second.

Shavshvebi IDP Cottage Settlement. This settlement has 177 cottages and 586 residents. The current latrines will be replaced with water supplied inside cottages and new buildings with showers and flush toilets. With water usage at 200 liters/person/day, the design flow for the treatment plant at Shavshvebi is expected to be 117 m^3/day. All sewage and wastewater will be piped into sewer systems that will transport wastewaters to the treatment plant. The map of the sewer network in the settlement and the location of the treatment plant are included in Annex A. Sewage will flow by gravity through the sewer pipeline to the treatment plant. The slope of the settlement is good for gravity flow. The community leader indicated that land is available for the treatment plant and that discharge to the nearby dry drain should not be an issue with neighbors. He planned to consult with neighbors. Biotal is the first choice recommendation for this settlement and a central septic tank and infiltration drain field is recommended second. Municipalities have indicated that sufficient land is not available for drain fields, and if this is the local situation here, then dry toilets like Enviro Loo may need to be considered if Biotal is not possible. But Biotal is the first choice recommendation.

Khurvaleti IDP Cottage Settlement. This settlement has 139 cottages and 460 residents. The current latrines will be replaced with water supplied inside cottages and new buildings with showers and flush toilets. With water usage at 200 liters/person/day, the design flow for the treatment plant at Khurvaleti is expected to be 92 m^3/day. All sewage and wastewater will be piped into sewer systems that will transport wastewaters to the treatment plant. The map of the sewer network in the settlement and the location of the treatment plant are included in Annex A. Sewage will flow by gravity through the sewer pipeline to the treatment plant. The slope of the settlement is nearly flat so special attention will be needed to insure that sewage flows properly to the treatment plant. The community leader indicated that land is available for the treatment plant and that discharge to the nearby drain should not be an issue with neighbors. Biotal is the first choice recommendation for this settlement and a central septic tank and infiltration drain field is recommended second. Municipalities have indicated that sufficient land is not available for drain fields, and if this is the local situation here, then dry toilets like Enviro Loo may need to be considered if Biotal is not possible. But Biotal is the first choice recommendation.

Teliani IDP Cottage Settlement. This settlement has 54 cottages and 164 residents. The current latrines will be replaced with water supplied inside cottages and new buildings with showers and flush toilets. With water usage at 200 liters/person/day, the design flow for the treatment plant at Teliani is expected to be 33 m^3/day. All sewage and wastewater will be piped into sewer systems that will transport wastewaters to the treatment plant. The map of the sewer network in the settlement and the location of the treatment plant are included in Annex A. Sewage will flow by gravity through the sewer pipeline to the treatment plant. Sewage will flow by gravity through the sewer pipeline to the treatment plant. The slope of the settlement is good for gravity flow. The community leader indicated that land is available for the treatment plant and that discharge to the nearby irrigation drain should not be an issue with neighbors. Biotal is the first choice recommendation for this settlement. The groundwater table is only 0.7 m deep, so a central septic tank and infiltration drain field is not possible. Biotal is the first choice recommendation and dry toilets like Enviro Loo are recommended second.

Tsilkani IDP Cottage Settlement. This settlement has 400 cottages and 1,093 residents. The current latrines will be replaced with water supplied inside cottages and new buildings with showers and flush toilets. With water usage at 200 liters/person/day, the design flow for the treatment plant at Tsilkani is expected to be 219 m^3/day. All sewage and wastewater will be piped into sewer systems that will transport wastewaters to the treatment plant. The map of the sewer network in the settlement and the location of the treatment plant are included in Annex A. Sewage will flow by gravity through the sewer pipeline to the treatment plant. The slope of the settlement is nearly flat so special attention will be needed to insure that sewage flows properly to the treatment plant. The community leader indicated that land is available for the treatment plant and that discharge to the nearby ditch that empties into a larger drain should not be an issue with neighbors. Biotal is the first choice recommendation for this settlement and a central septic tank and infiltration drain field is recommended second. Municipalities have indicated that sufficient land is not available for drain fields, and if this is the local situation here, then dry toilets like Enviro Loo may need to be considered if Biotal is not possible. But Biotal is the first choice recommendation.

Frezeti IDP Cottage Settlement. This settlement has 300 cottages and 721 residents. The current latrines will be replaced with water supplied inside cottages and new buildings with showers and flush toilets. With water usage at 200 liters/person/day, the design flow for the treatment plant at Frezeti is expected to be 144 m^3/day. All sewage and wastewater will be piped into sewer systems. However, because of the slopes involved in Frezeti, about half of the cottages will use one sewer network to a treatment plant and the other half (that slopes in the opposite direction) will flow through a second sewer system that discharges into a second treatment plant. The map of the sewer network in the settlement and the location of the treatment plant are included in Annex A. Sewage will flow by gravity through the two sewer pipelines to the two treatment plants. The slope of the settlement is good for gravity flow. There are 5-6 cottages that may need special attention as their sewage may not flow by gravity to either of the two treatment plants planned. The community leader indicated that land is available for the treatment plant and that discharge to the nearby drains (that flow downhill to a stream or river) should not be an issue with neighbors. Biotal is the first choice recommendation for this settlement and a central septic tank and infiltration drain field is recommended second. Municipalities have indicated that sufficient land is not available for drain fields, and if this is the local situation here, then dry toilets like Enviro Loo may need to be considered if Biotal is not possible. But Biotal is the first choice recommendation.

Based on a review of these technologies, their use and performance in Georgia and their technical and economic feasibility, environmental and social effects, Biotal Biological Treatment is recommended as the first choice for sewage treatment in the nine IDP cottage settlements in Table 6. Use of a central septic tank and infiltration drain field is recommended second for settlements with groundwater levels that permit infiltration drain fields. This septic tank technology is highly rated but there is a concern about pollution of the groundwater, O&M may prove to be a problem and municipalities have expressed concern about the availability of sufficient land for these systems. For the three settlements with high groundwater tables, dry toilet systems like Enviro Loo are recommended as the second choice. Dry toilets are rated high, but they are not available in Georgia and there are questions about their acceptance by IDPs. (Also note that dry toilets are recommended for Berbuki based on high groundwater levels indicated by the community leader. If after further assessment, the groundwater is determined to be at adequately low levels, then septic tanks and infiltration drain fields would be the second choice recommendation.)

After full assessment of the available technologies, BIOTAL is recommended as first choice for all nine IDP cottage settlements. Recommendations are provided in Table 6.

Table 6: Recommended Wastewater Treatment for IDP Cottage Settlements

	Cottage Settlement	Recommended	Recommendation #2
1	Akhalsopeli	**Biotal** Biological Treatment	Central Septic Tank + Infiltration Drain Field*
2	Mokhisi	**Biotal** Biological Treatment	Dry Toilets like Enviro Loo
3	Skra	**Biotal** Biological Treatment	Central Septic Tank + Infiltration Drain Field*
4	Berbuki	**Biotal** Biological Treatment	Dry Toilets like Enviro Loo
5	Shavshvebi	**Biotal** Biological Treatment	Central Septic Tank + Infiltration Drain Field*
6	Khurvaleti	**Biotal** Biological Treatment	Central Septic Tank + Infiltration Drain Field*
7	Teliani	**Biotal** Biological Treatment	Dry Toilets like Enviro Loo
8	Tsilkani	**Biotal** Biological Treatment	Central Septic Tank + Infiltration Drain Field*
9	Frezeti	**Biotal** Biological Treatment	Central Septic Tank + Infiltration Drain Field*

Note: * Central Septic Tank + Infiltration Drain Field is #2 recommendation for cottage settlements 1, 3, 5, 6, 8 and 9. For any of these settlements, if sufficient land is not available for infiltration drain fields, then Recommendation #2 would be Dry Toilets like Enviro Loo.

IMPLEMENTATION STEPS

The results and recommendations in this report will be reviewed and discussed with USAID and with the Municipal Development Fund (MDF) and the GMIP Steering Committee. The pros and cons of preliminary recommendations will be evaluated for each settlement and a GMIP recommendation will be determined for each settlement. The BOQs and technology drawings for each treatment system (See Annex D: Treatment Technology BOQs and Feasibility Drawings) will be used to prepare contracting documents. The results in this report will be used to determine the specific sewer and treatment system needs and design for each of the nine cottage settlements. After selection of vendors for the sewer systems and treatment systems, detailed contract conditions will be established. The "Additional Considerations" described below will be addressed. Construction contracts will be monitored and evaluated throughout the term of the contracts. The contracts will also include the Environmental Mitigation and Monitoring Plans (EMMPs) in the GMIP Programmatic Environmental Assessment (PEA) for Durable Housing.

ADDITIONAL CONSIDERATIONS

There are three areas of concern that warrant additional discussion and consideration: construction of sewer networks with proper engineering, type and location of discharge receiving drain; and O&M monitoring of Biotal operation.

- Three IDP cottage settlements (Berbuki, Khurvaleti and Tsilkani) are located on relatively flat lands and the construction of sewer networks will require strict attention to land slopes to insure the sewage will flow to the treatment plant. During discussions at the cottage settlements, community leaders often complained about concrete drains that were constructed without adequate slope needed to drain the water from the settlement. Detailed construction oversite is key for ensuring that proper engineering slopes are used throughout the settlement. This concern applies to Biotal or septic tank technologies.

- With the recommended Biotal biological treatment technology, many of the IDP cottage settlements would discharge into dry or abandoned irrigation channels or dry ditches that would flow for many kilometers before reaching streams or rivers. Treated sewage discharges will flow through these ditches and drains with some leakage into the soil and possibly into groundwater. While these treated wastewaters will be low in pollution, leakage may be an issue. There is also a question about discharging into existing irrigation channels. Community leaders thought that there would not be any problems with discharge into these channels and that neighbors would not complain. Several leaders planned to check with neighbors about concerns with the treated sewage discharges.

- Biotal in Georgia offers a technology monitoring component for IDP settlements and others. They visit the treatment plant monthly to inspect operations. They use bottles to check on solids separation and settling rates in the aeration tanks. They check for solids in the final discharge and they use odor as a tool to assess performance. Low odor levels indicate good sludge operating conditions and proper treatment performance. These measures need to be supplemented with additional monitoring techniques. Chlorination requires periodic measure of fecal coliforms and total coliforms in final discharges in order to assess effectiveness of disinfection. Sewage inflows and final effluents should be checked periodically for BOD or COD (measures of organic pollution in and out of the treatment system). This will provide assessment of treatment performance and possible problems in the sewer network or treatment system. Sludge settling should be monitoring with graduated cylinders using the Sludge Volume Index. Monitoring of the final effluent suspended solids level would validate the performance of the final clarification and solids management including cycles for returning and wasting proper amounts of sludge.

These concerns and considerations will be included in construction contracts implementing the treatment technologies selected for IDP cottage settlements.

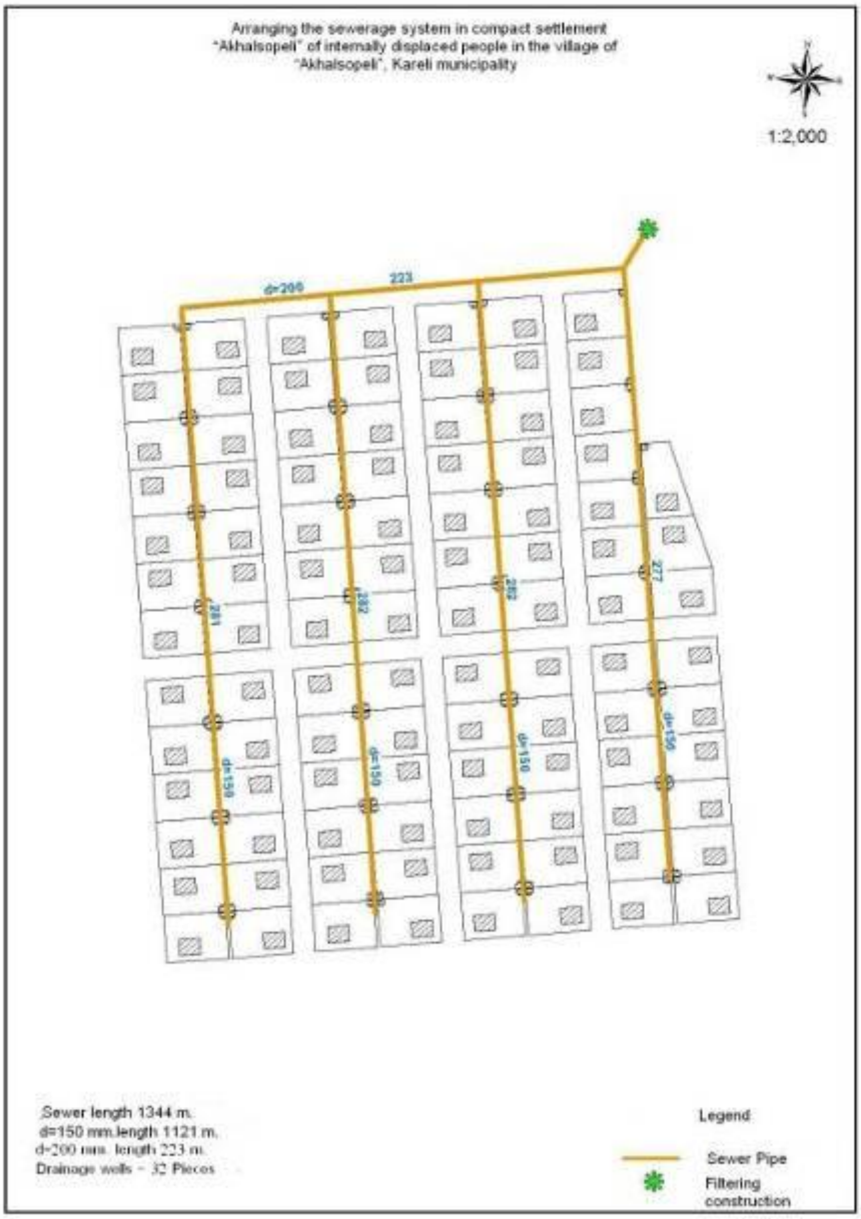
Annex A Maps, Diagrams and Pictures of Cottage Settlements

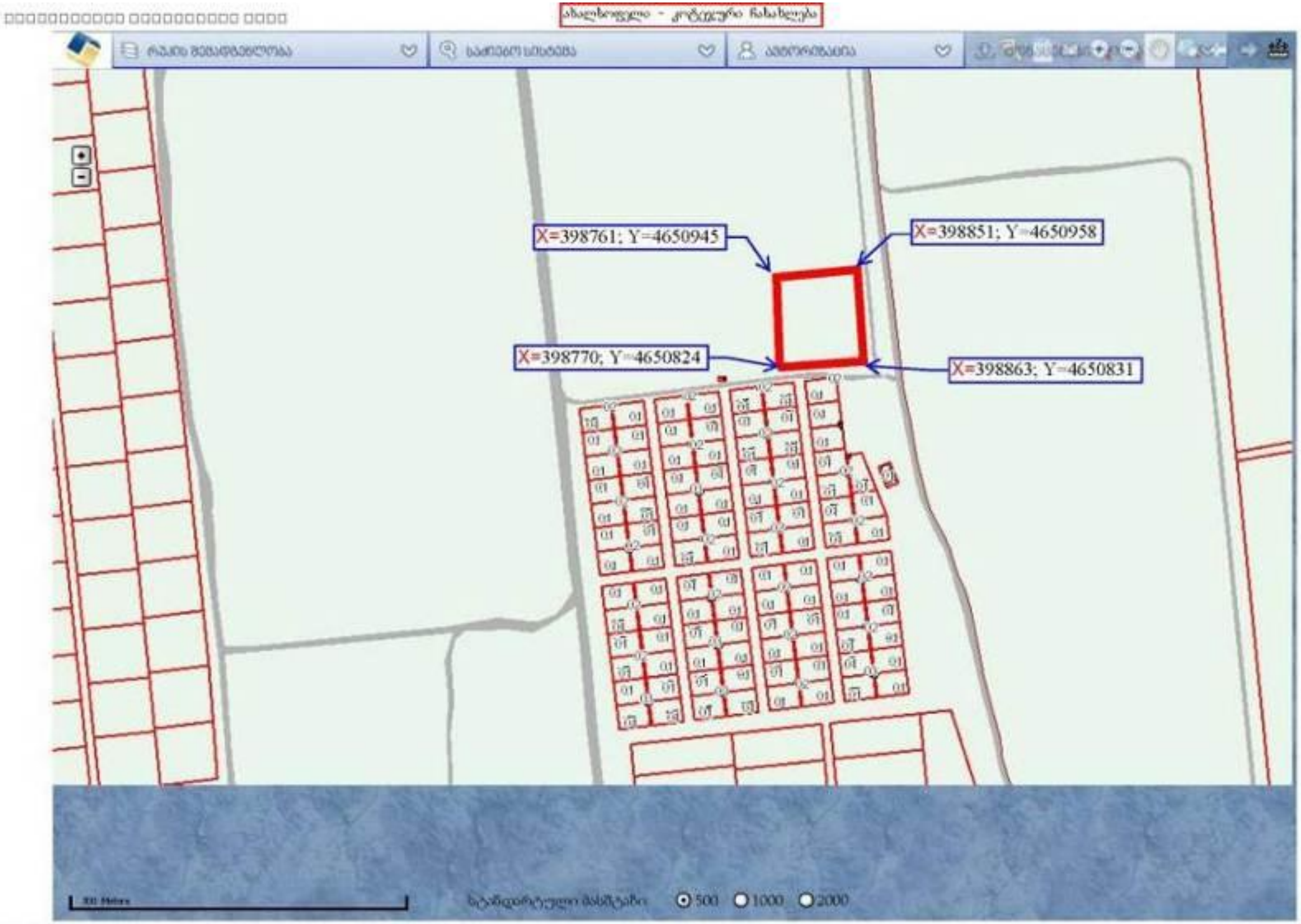
Cottage Settlements

1. Cottage Settlement “Akhalsopeli”
2. Cottage Settlement “Mokhisi”
3. Cottage Settlement “Skra”
4. Cottage Settlement “Karaleti”
5. Cottage Settlement “Berbuki”
6. Cottage Settlement “Shavshvebi”
7. Cottage Settlement “Khurvaleti”
8. Cottage Settlement “Teliani”
9. Cottage Settlement “Metekhi”
10. Cottage Settlement “Tsilkani”
11. Cottage Settlement “Frezeti”
12. Cottage Settlement “Tserovani”
13. Cottage Settlement “Sakasheti”
14. Cottage Settlement “Verkhvebi”

1. Settlement “Akhalsopeli”

Map of proposed sewer network – Akhalsopeli





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Photos

Akhalsopheli Settlement

Irrigation channel at the end of settlement

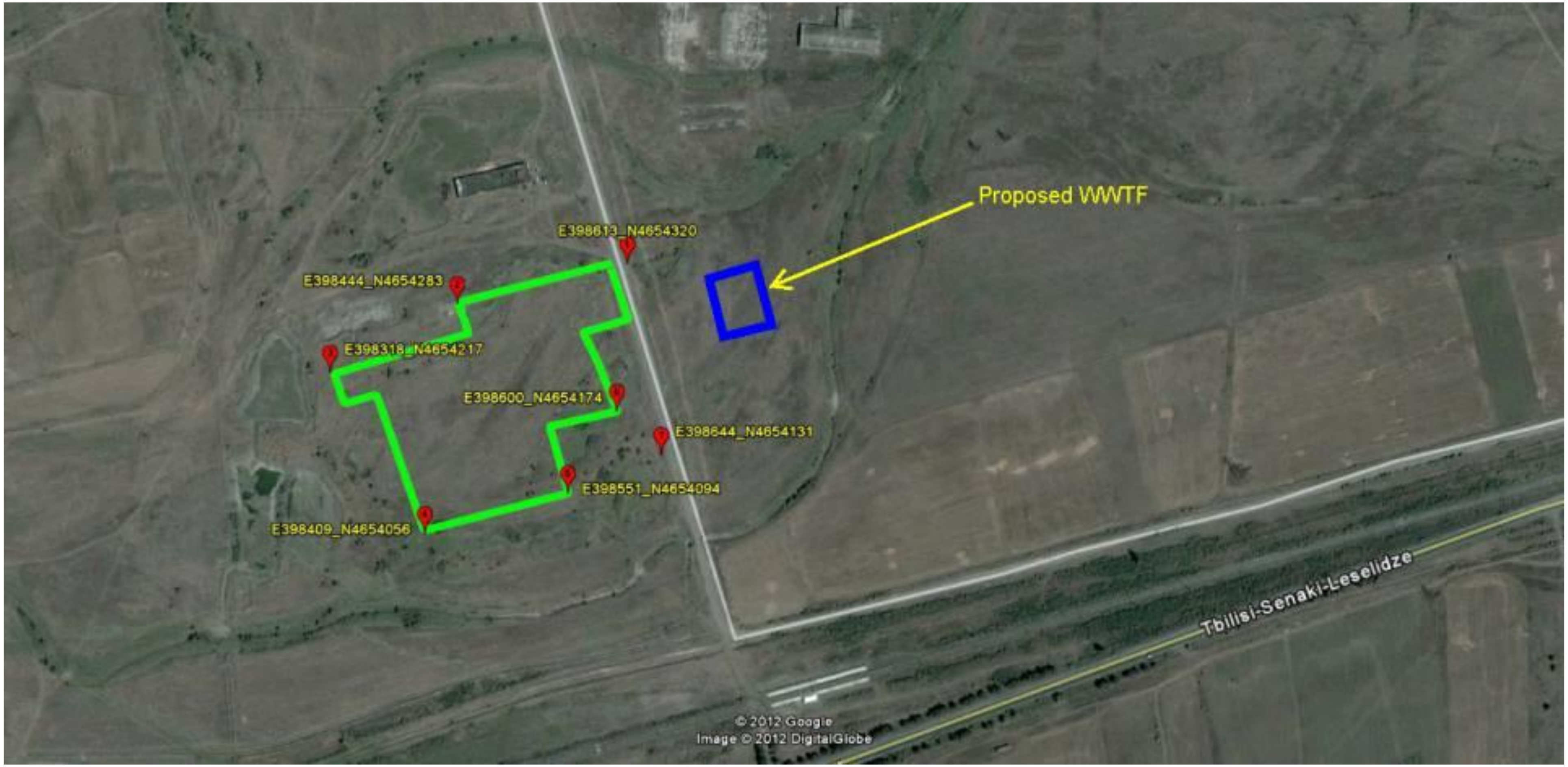
Surface drain system needs rehabilitation

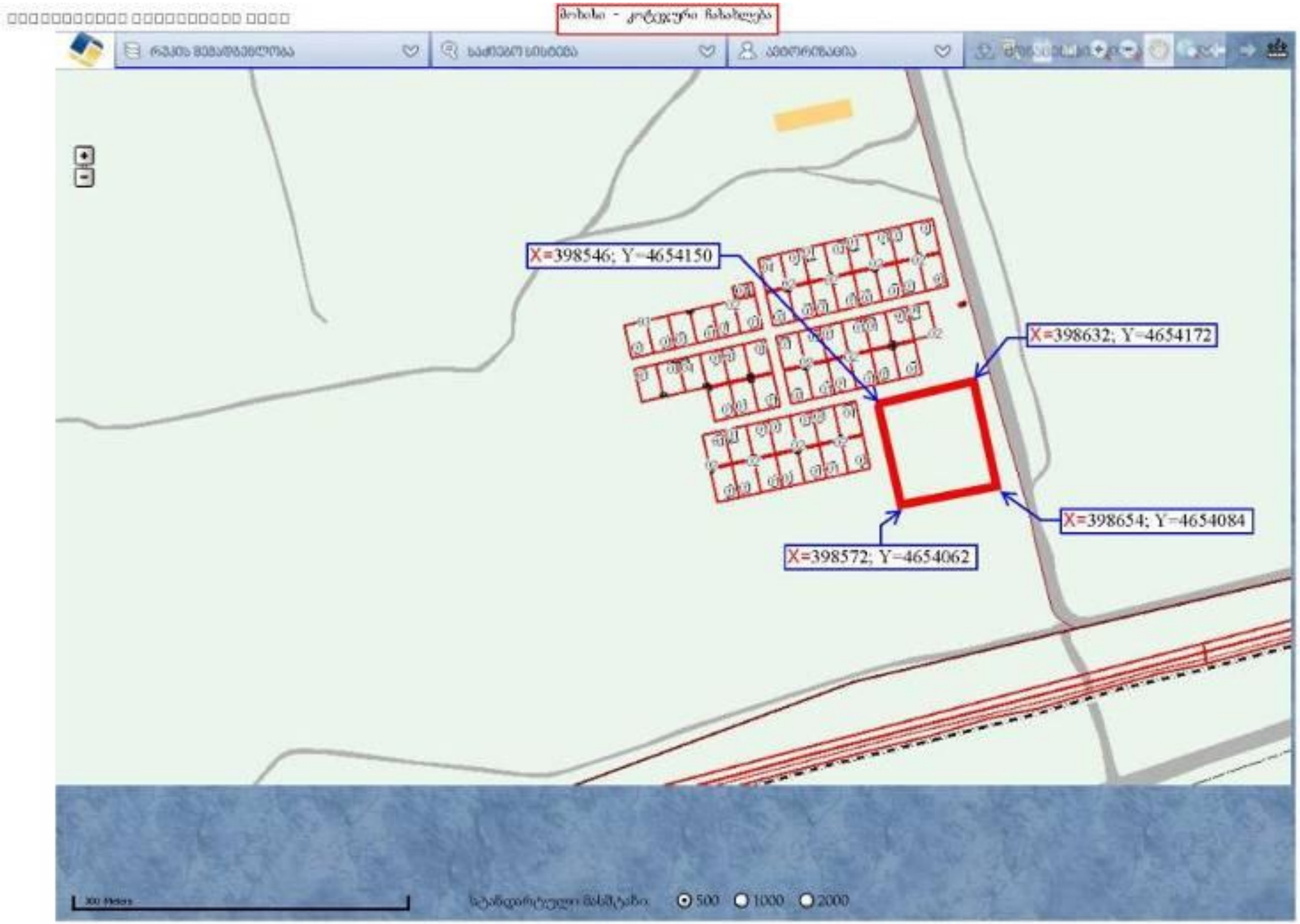
Mold on the cottage interior walls

90% of cottages have mold problems

Street water taps

2. Settlement "Mokhisi"





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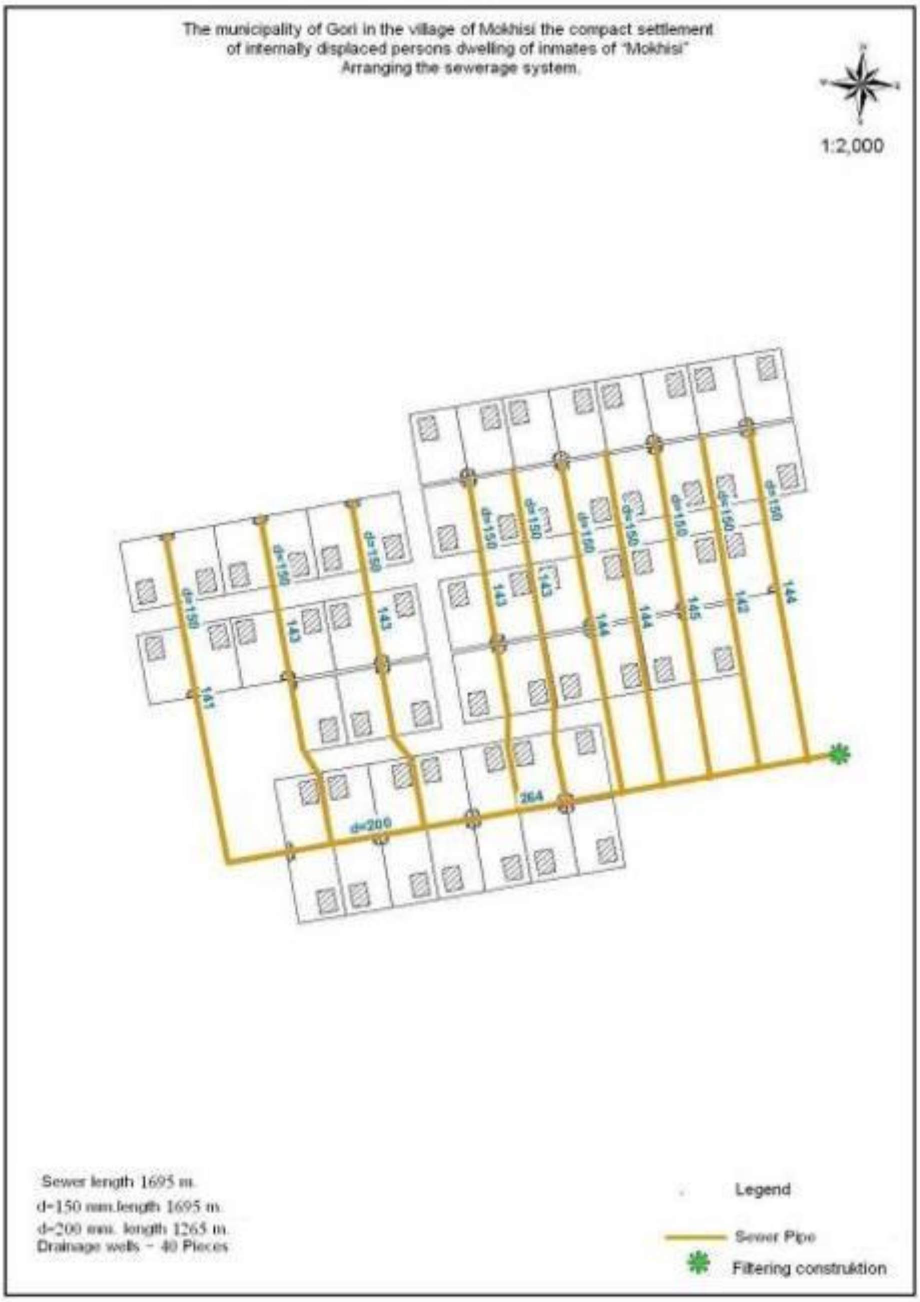
Map of proposed sewer network – Mokhisi



Photos

Mokhisi Settlement

90% of cottages have mold problems

Wooden outdor toilets

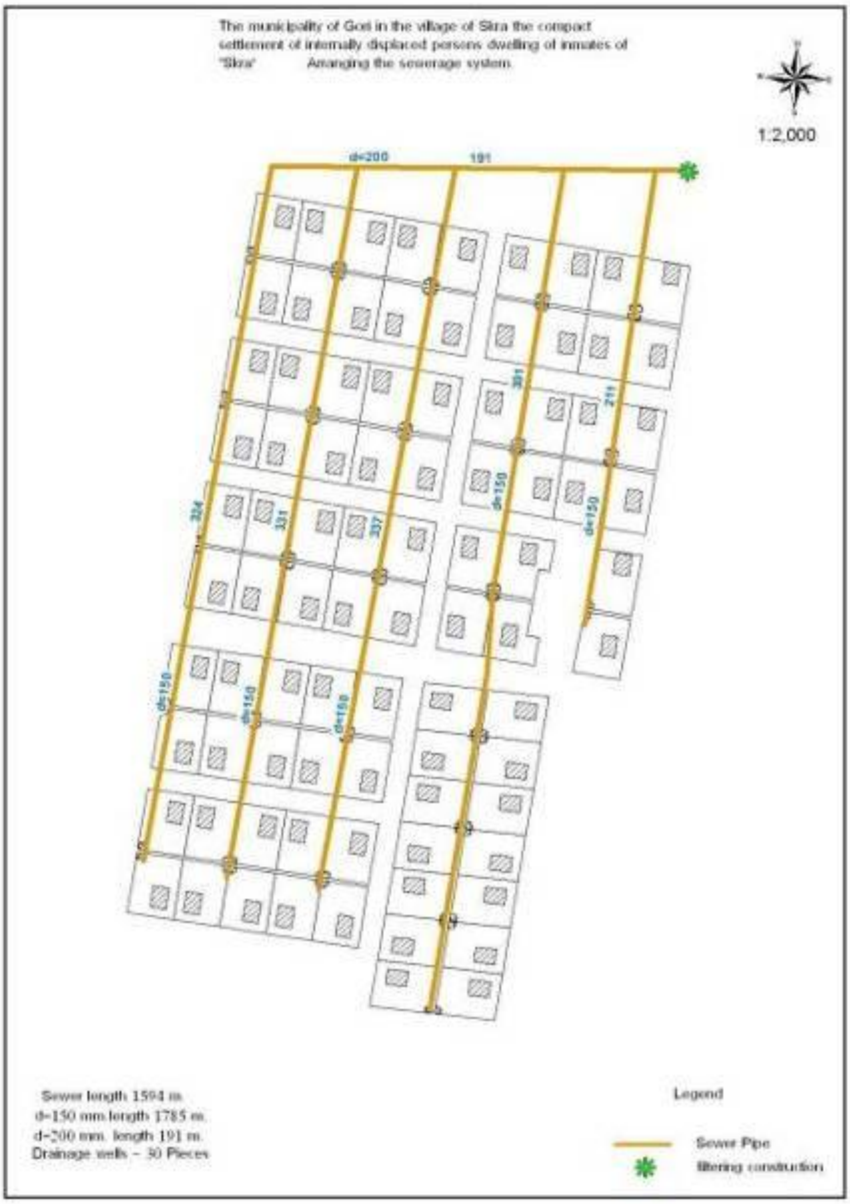
Bathhouse septic tank

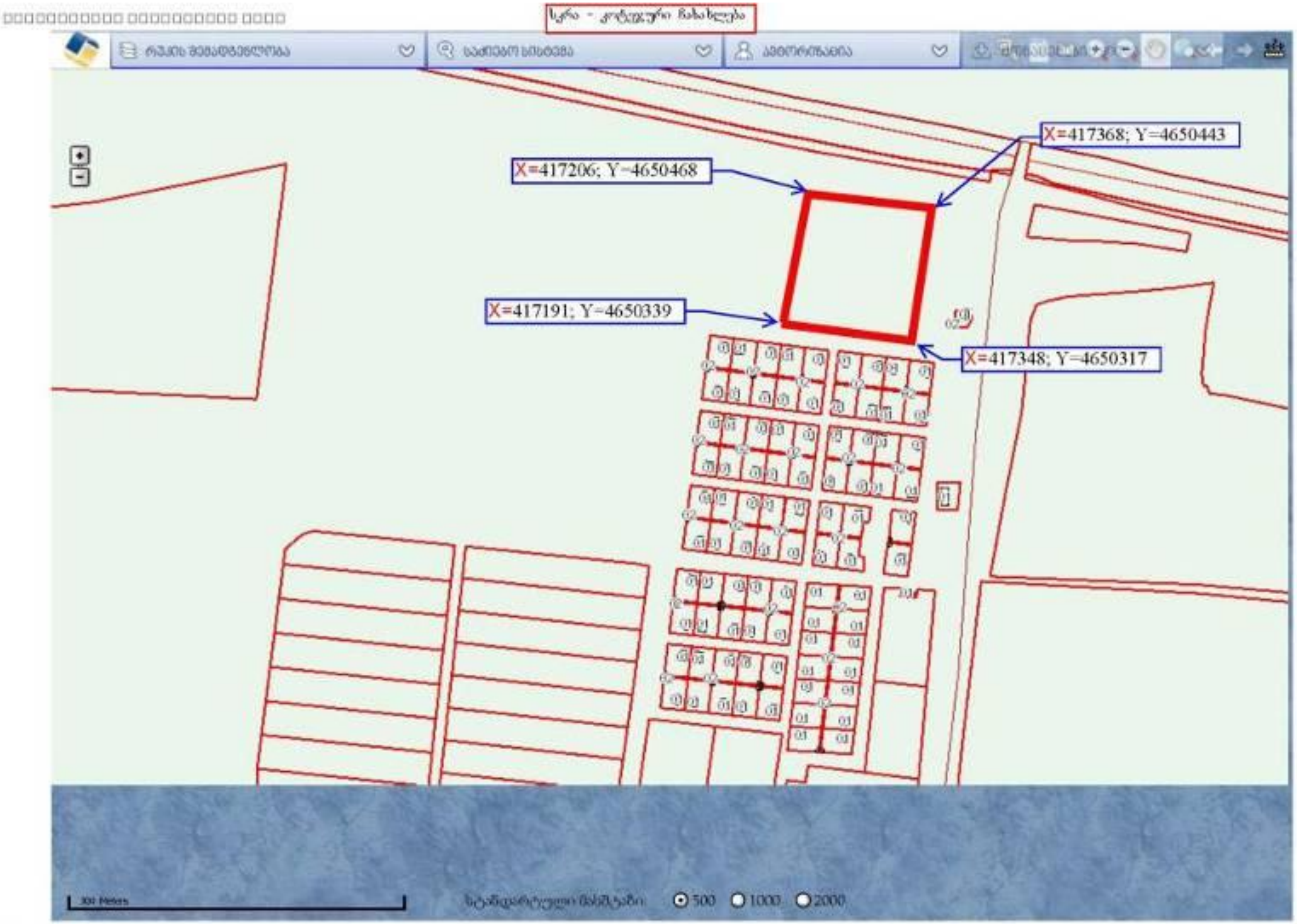
Drain channels are lined with concrete

Access for pump trucks

3. Settlement "Skra"

Map of proposed sewer network – Skra





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Photos

Skra settlement

Drain channels are lined with concrete

Thermal insulation of cottage walls is completed

Wooden toilets and shared storage buildings

Single storage building

Bathhouse septic tank

4. Settlement “Karaleti”

Photos

Karaleti settlement

Irrigation water well

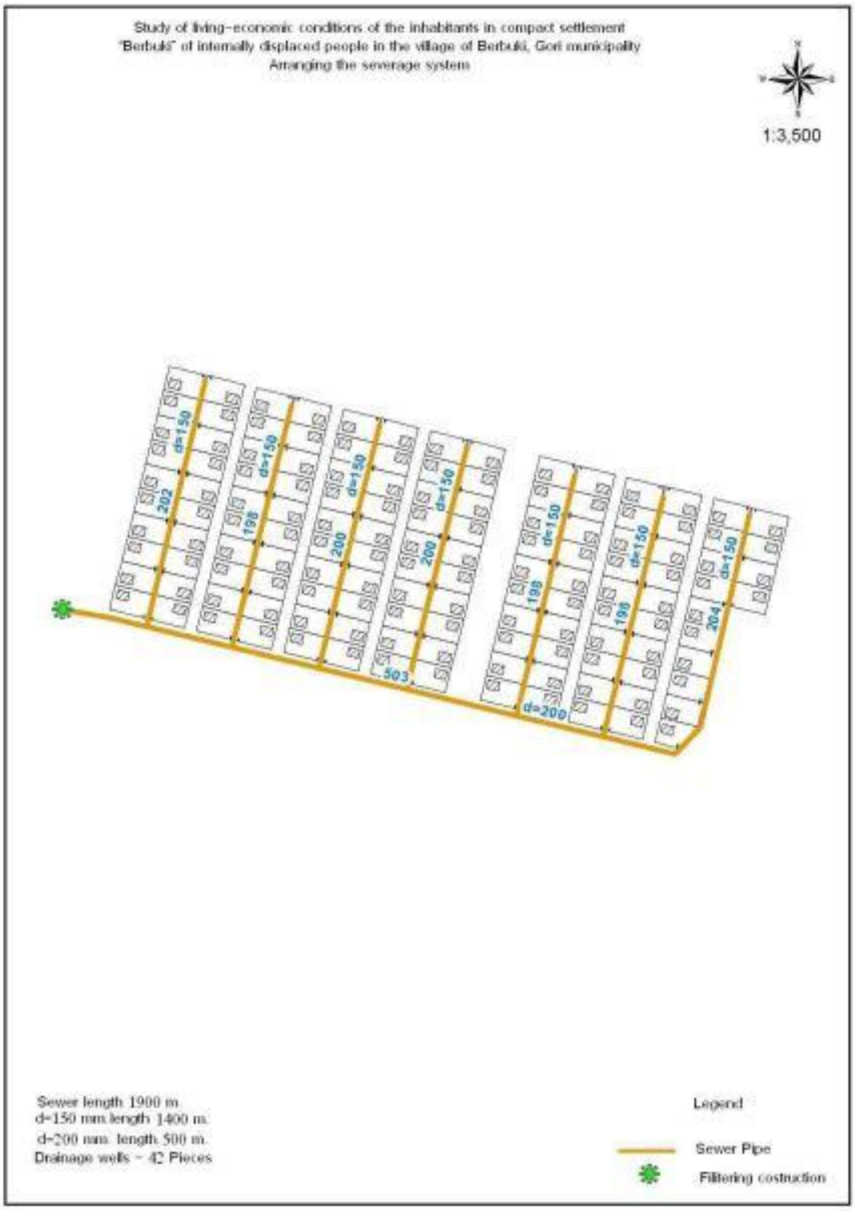
Water tower

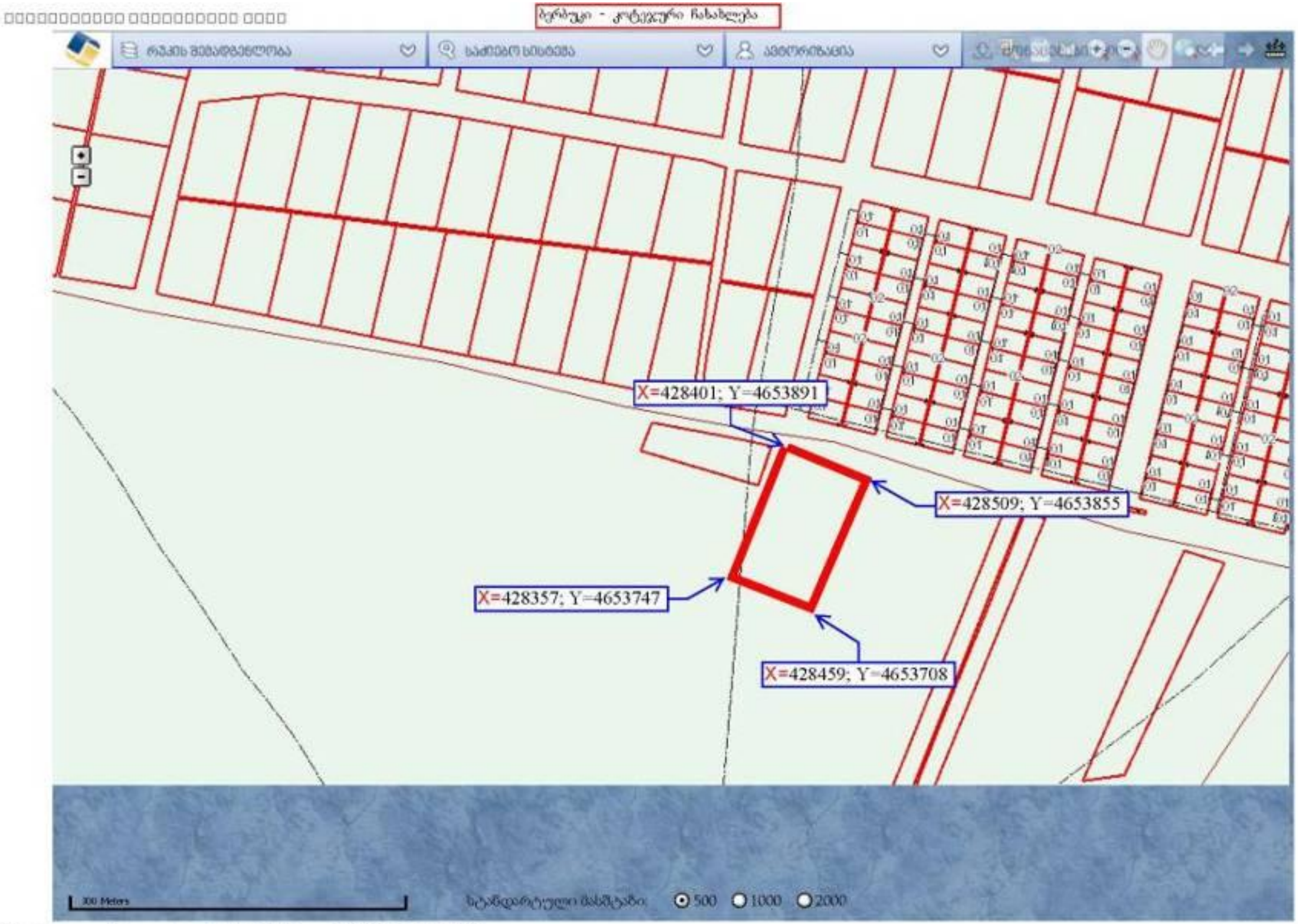
Owner constructed open shed

Garbage have been removed systematically

5. Settlement “Berbuki”

Map of proposed sewer network – Berbuki





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Photos

Berbuki settlement

Proposed treated WW dumping channel

Wooden toilet needs to be pumped out once per month

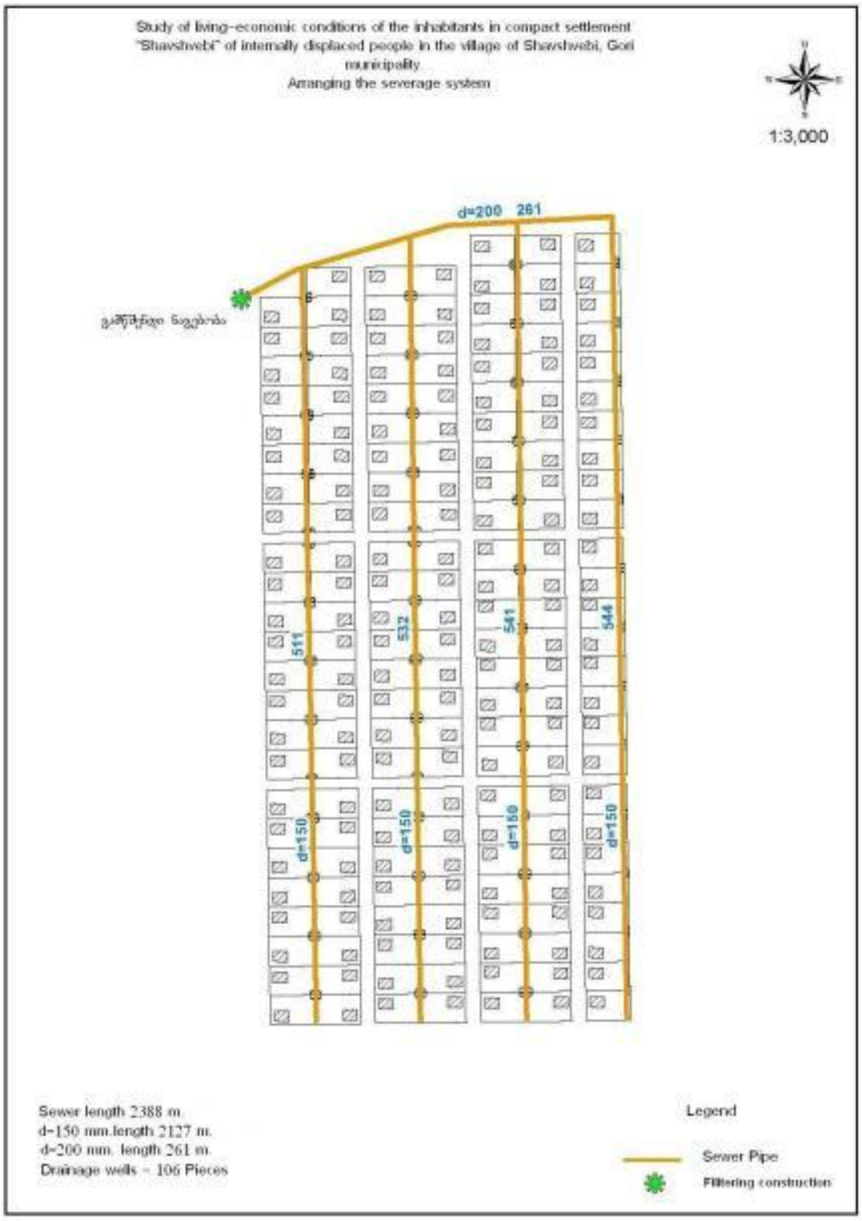
Bathhouse septic tank

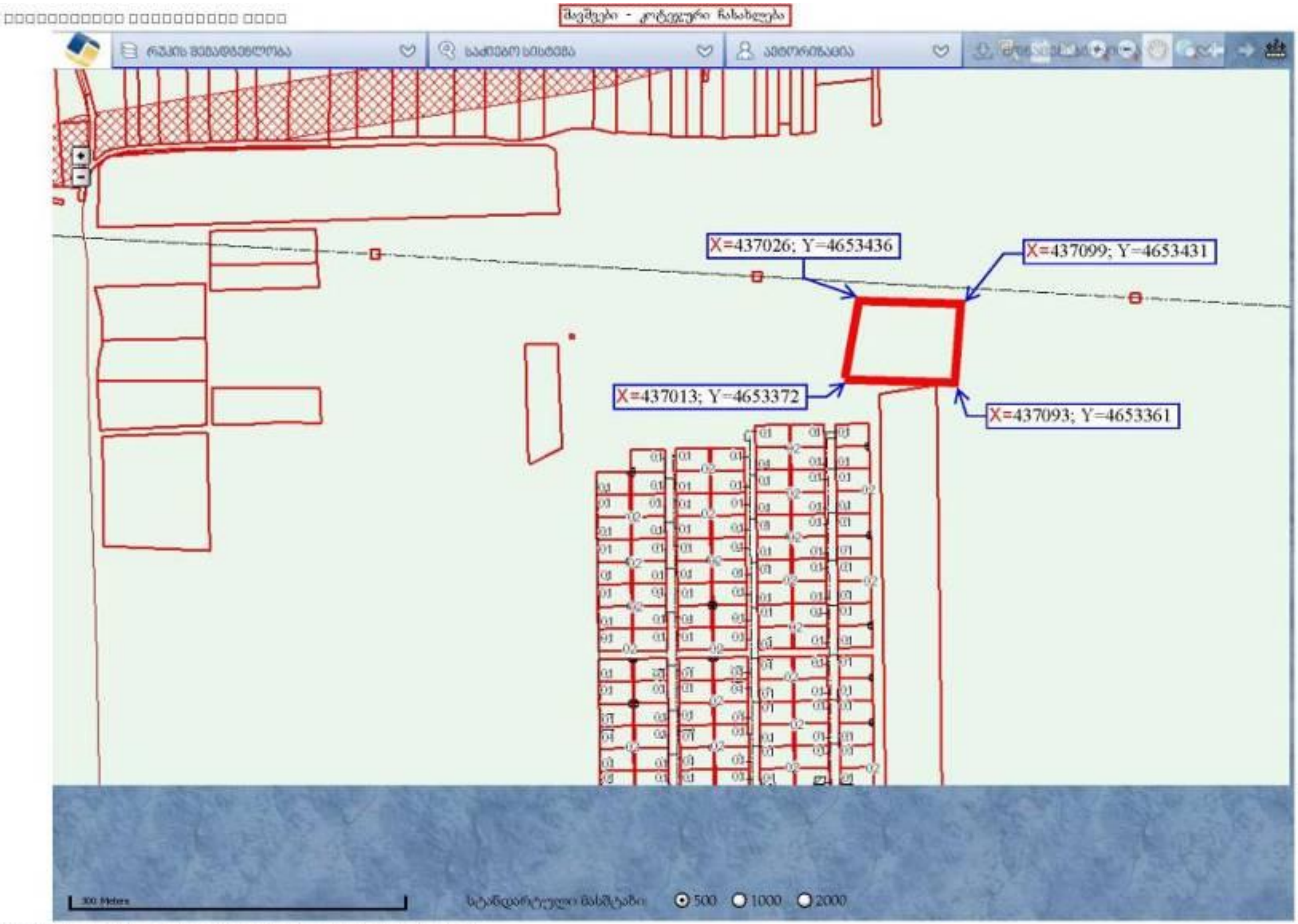
Proposed WWTF place

Access for the pump truck

5. *Settlement “Shavshvebi”*

Map of proposed sewer network – Shavshvebi





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Photos

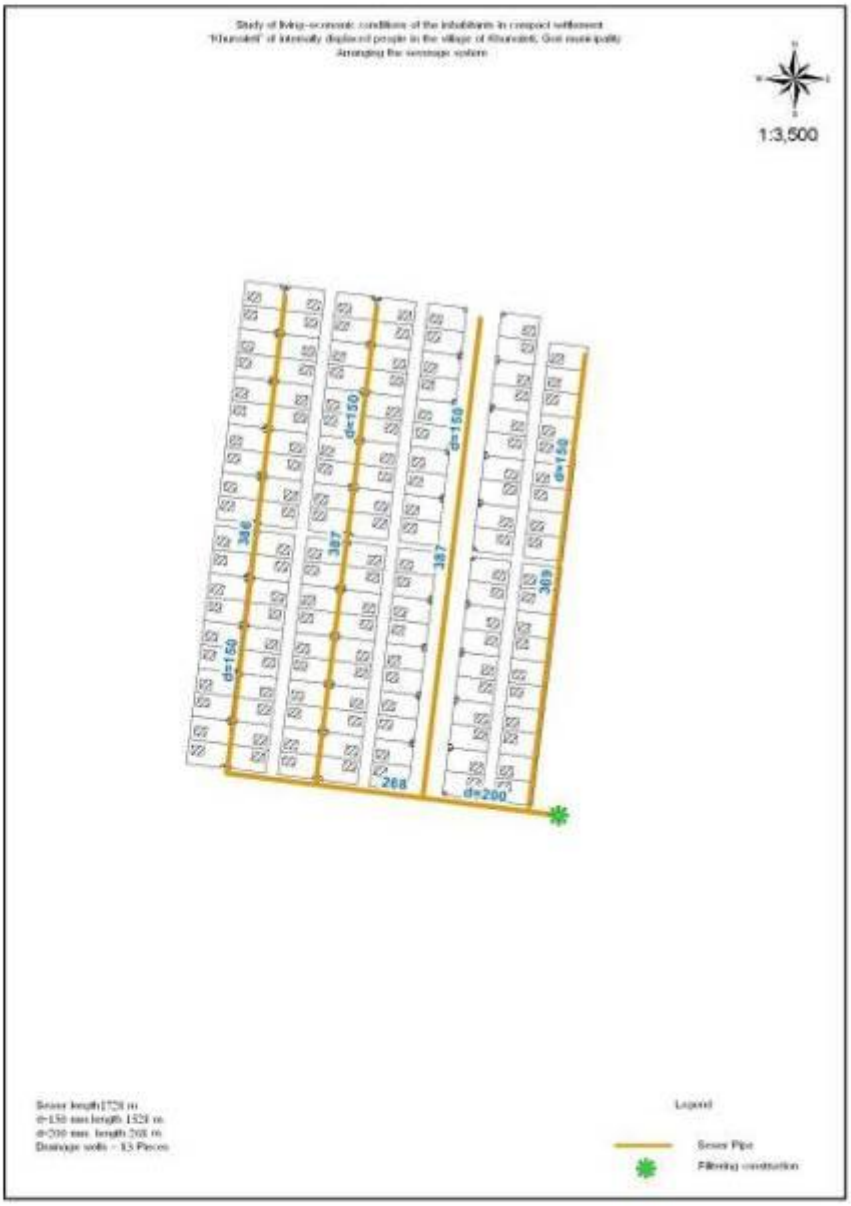
Shavshvebi settlement

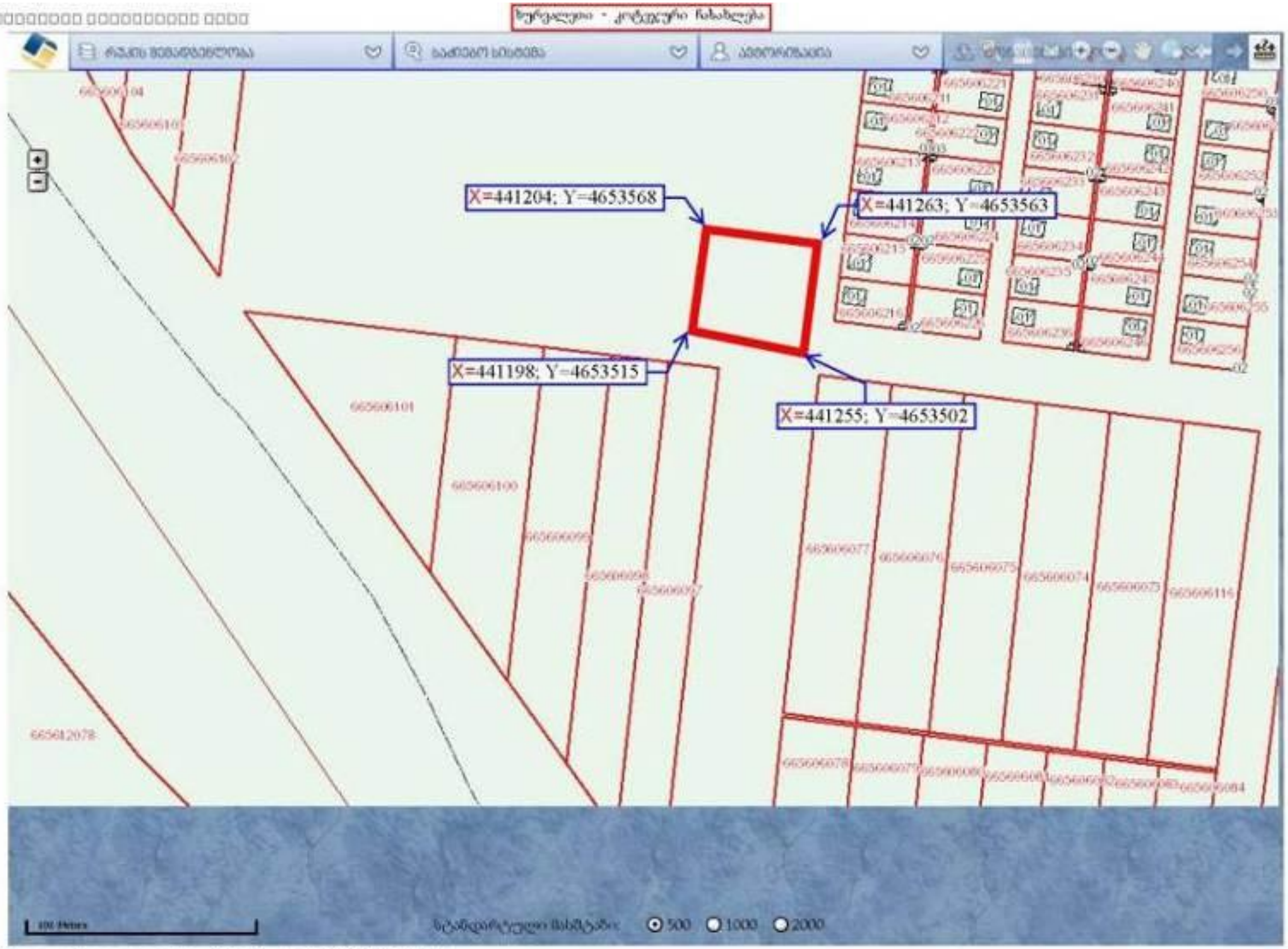
80% cottages have mold problems

Existing water borehole has high nitrate concentration level, other W/S must be defined

6. *Settlement "Khurvaleti"*

Map of proposed sewer network – Khurvaleti





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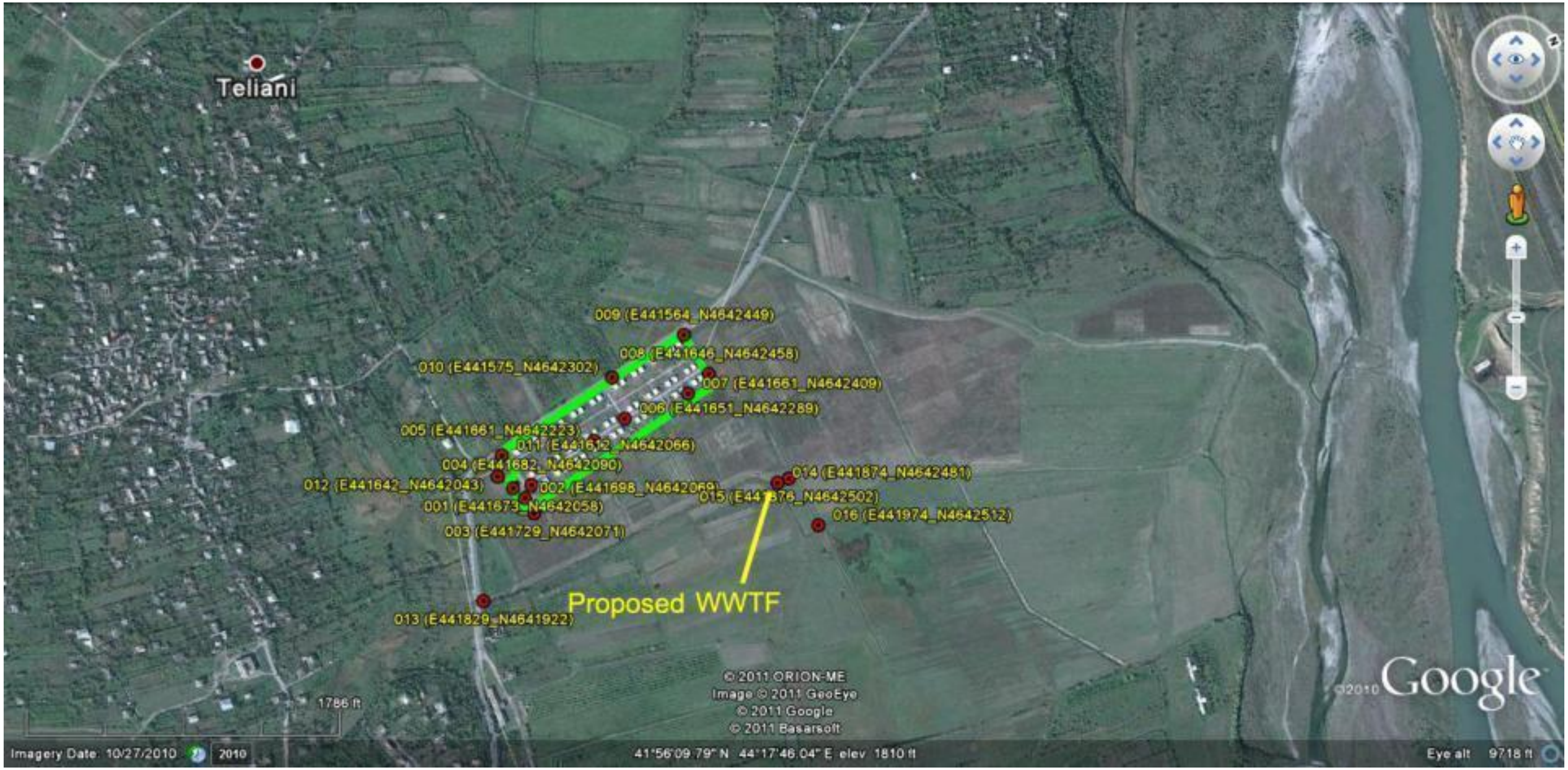
Photos

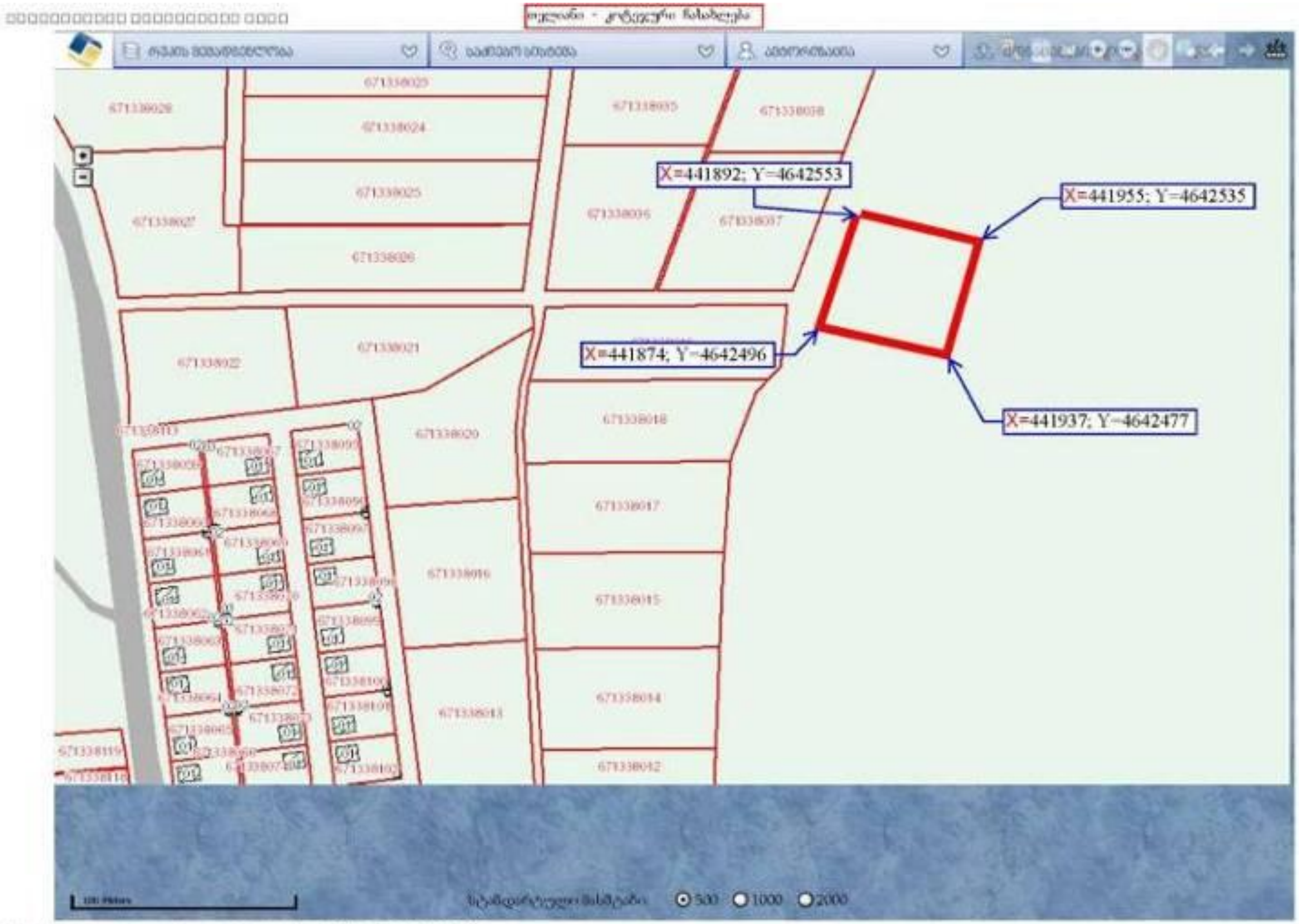
Khurvaleti settlement

Two cottages have concrete holding tanks

7. Settlement "Teliani"



Map of proposed sewer network – Teliani



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Photos

Teliani Settlements

Water distribution well

Access road

Bathhouse septic tank

Access for pump truck between toilets

Exposed W/S pipe in the river bad

8. Settlement "Metekhi"

Photos

Metekhi settlement

Sewage manholes

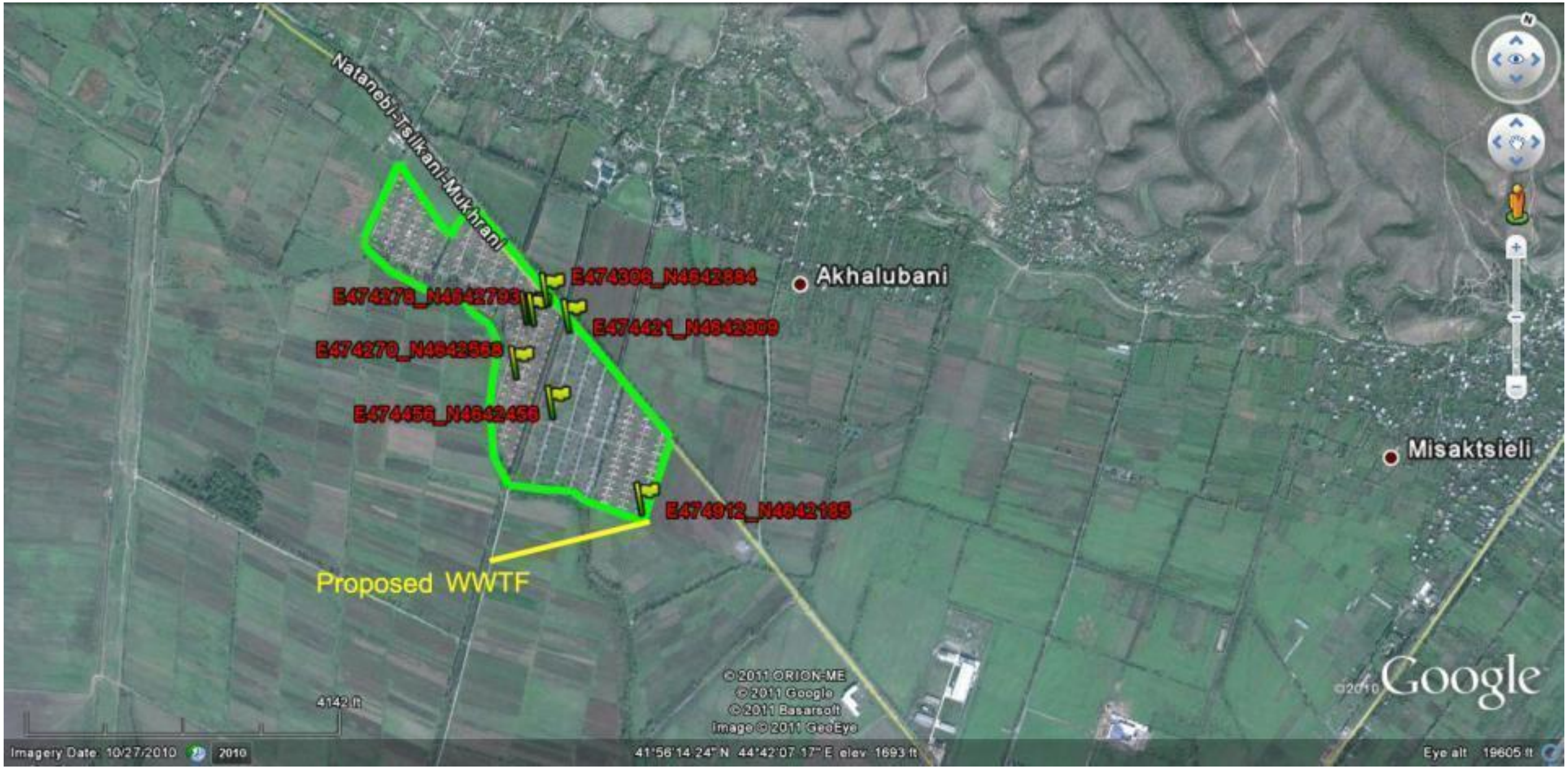
Central septic tank

Single Toilet/Shower building

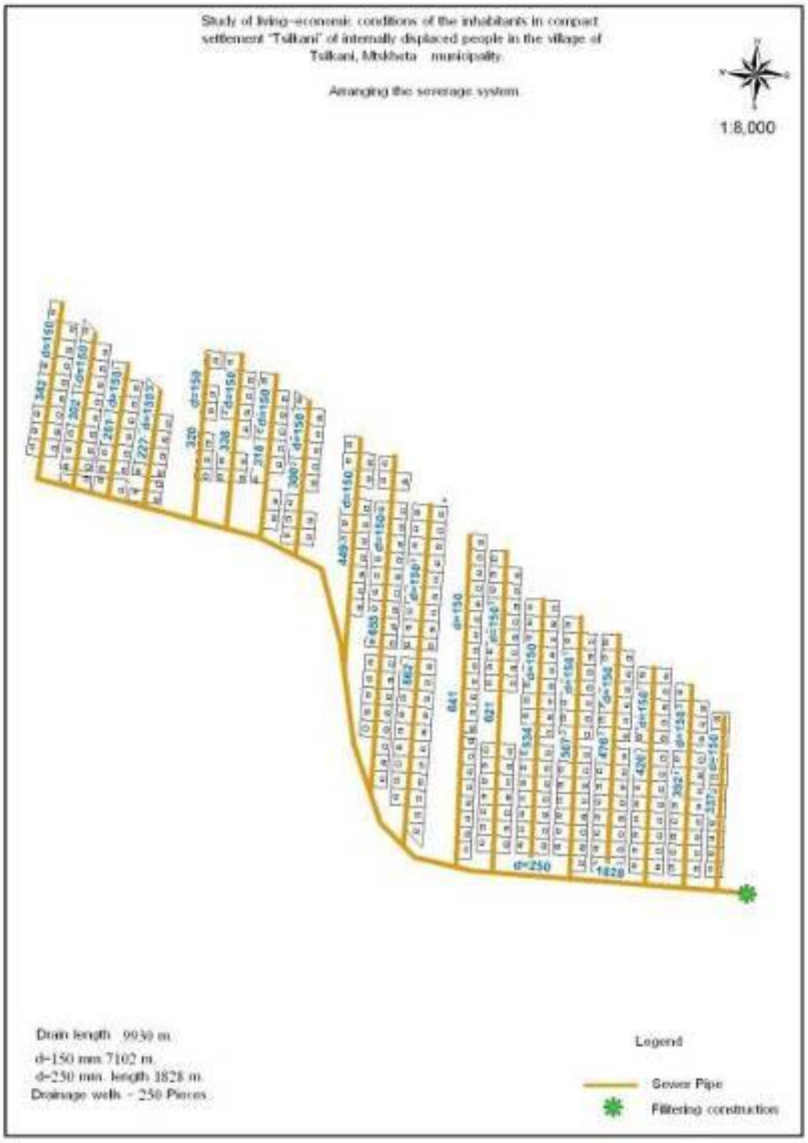
Existing flash toilet

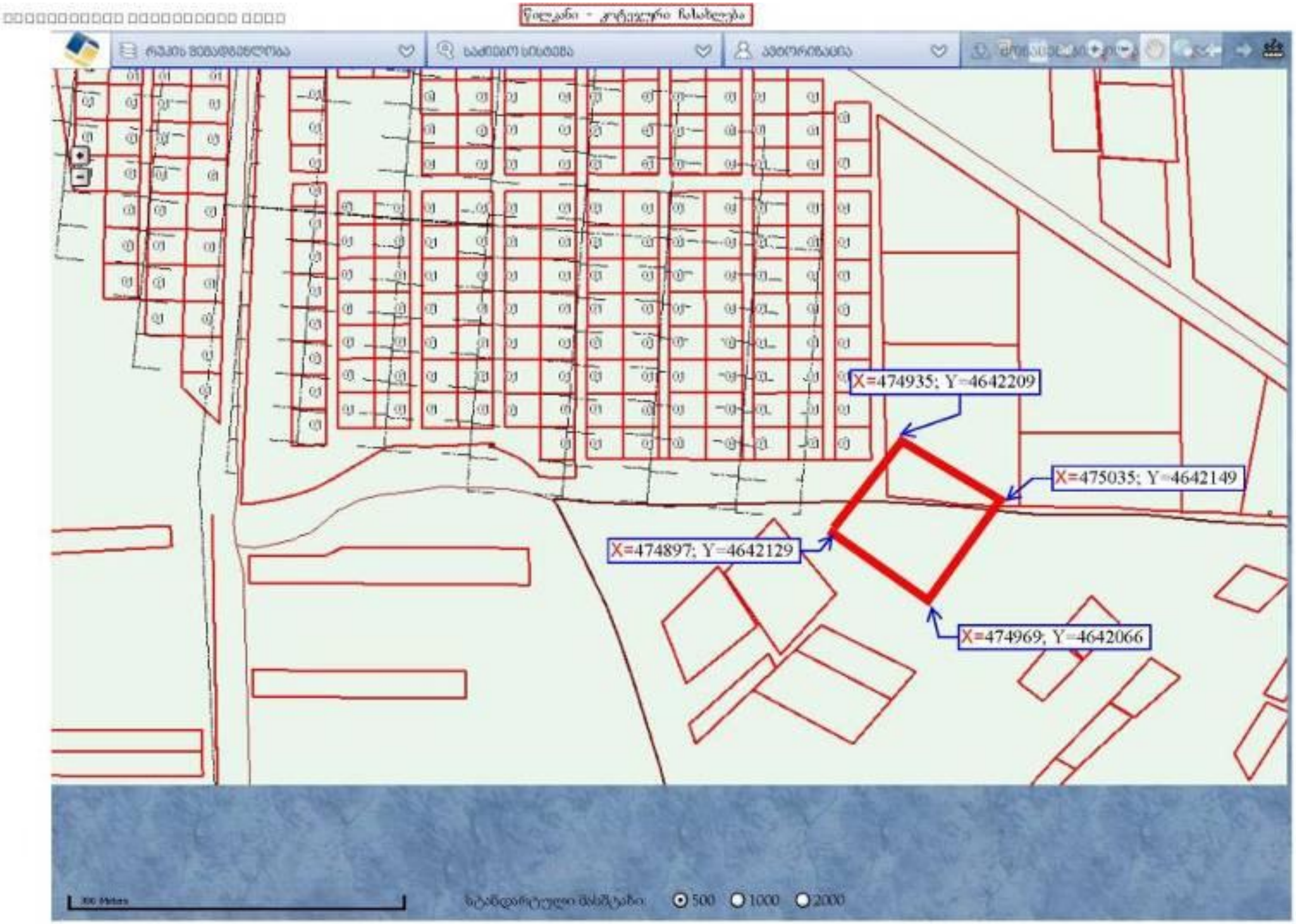
Double Toilet/Shower with storage building

9. Settlement "Tsilkani"



Map of proposed sewer network – Tsulkani





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Photos

Tsilkani settlement

Drinking water tap

Owner constructed storage shed

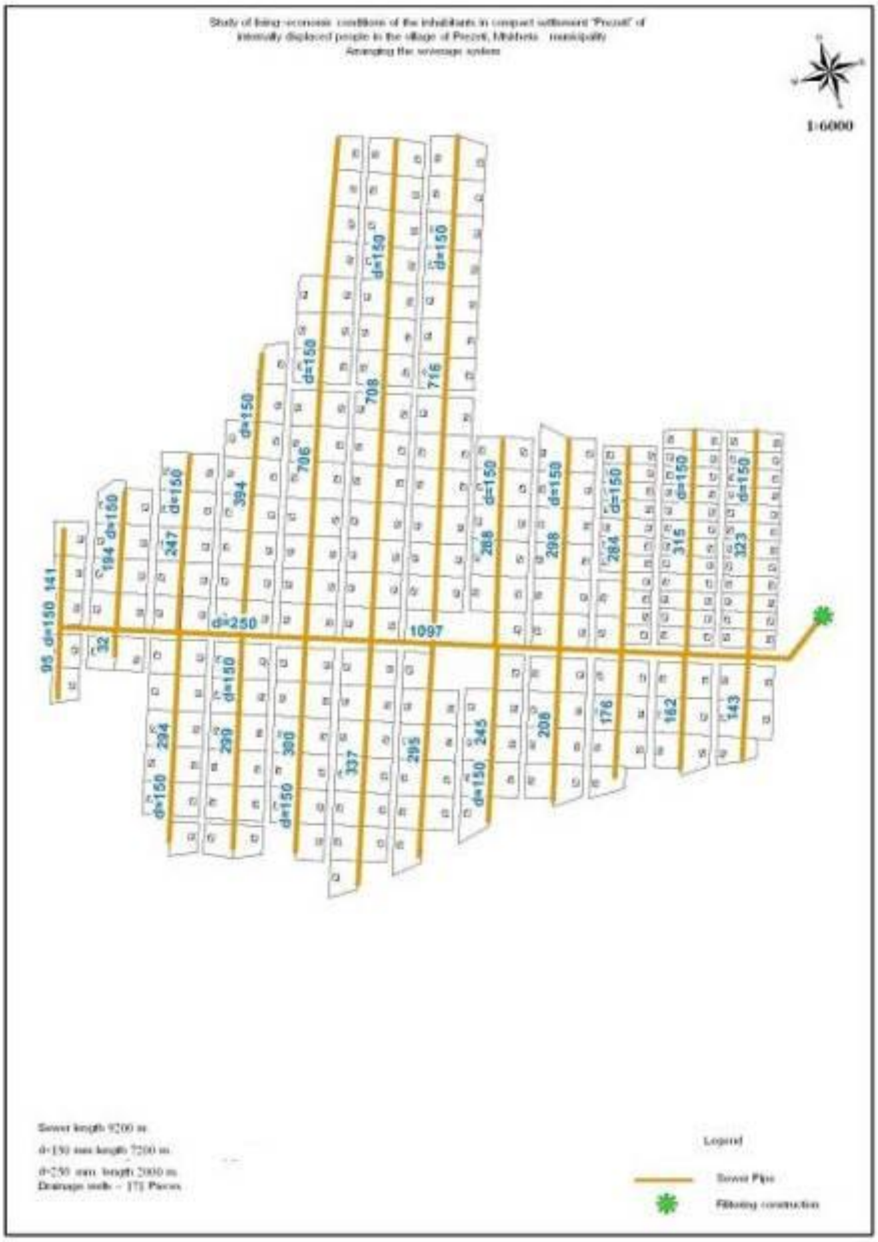
Irrigation water tap

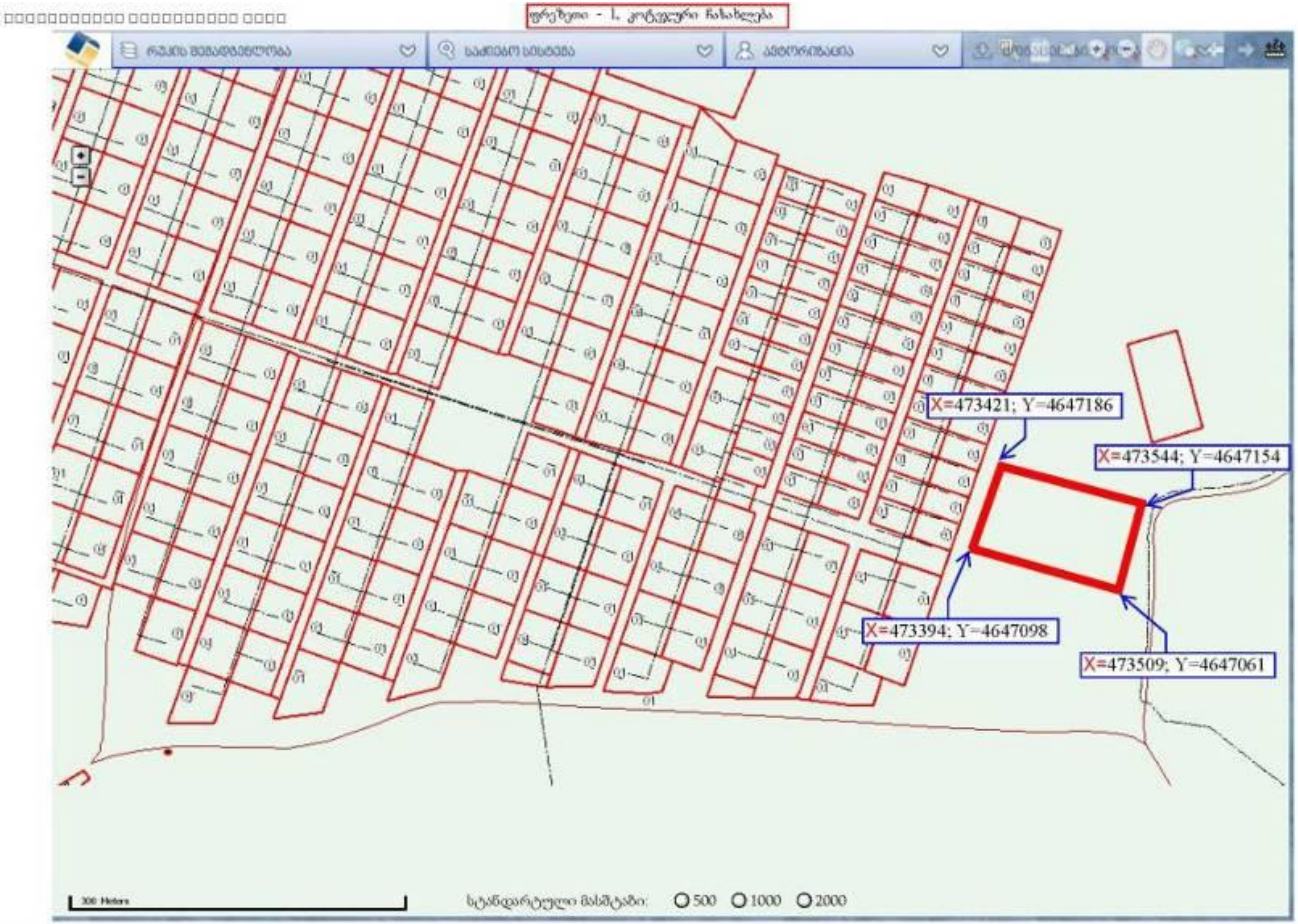
Drainage system needs rehabilitation

Wooden outdoor toilet

10. Settlement "Frezeti"

Map of proposed sewer network – Frezeti





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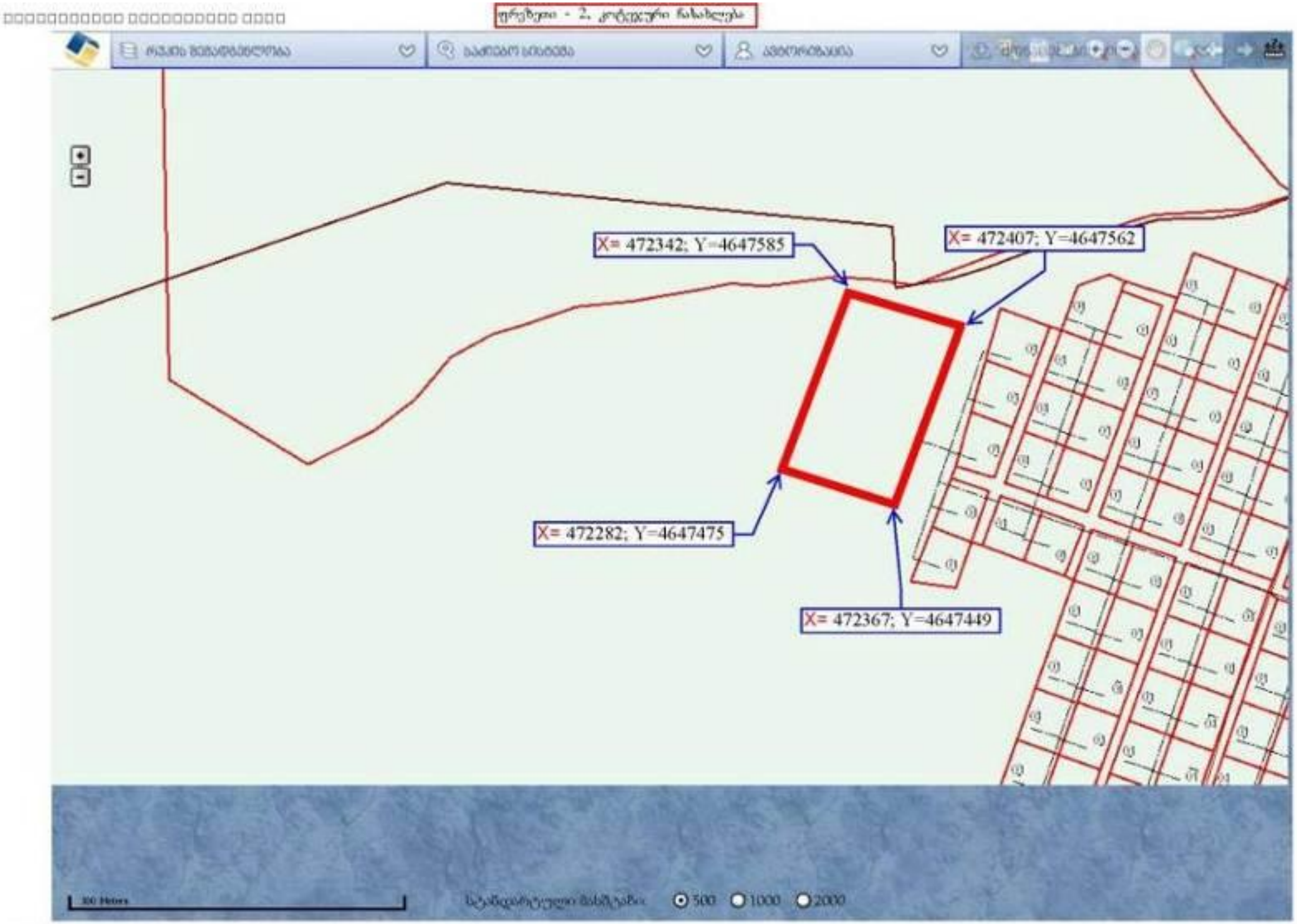

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Photos

Frezeti settlement

Proposed WW dumping channel #1

Proposed WWTF site #1

Proposed WWTF site #2,dumping channel

Gutters are broken and removed

Walls must be hydro-insulated

5. Settlement "Tserovani"

Photos

6. *Settlement "Sakasheti"*

Photos

Sakasheti settlement

Corn storage

Sheared sewage sock-pit for 2 cottages

Toilets are inside the cottages

Waste area

Cottage heater

1. *Settlement "Verkhvebi"*

Photos

Sewage manhole

Garbage collection point

Verkhvebi settlement

Access road

Cracks on the wall

Wrestling stadium

Annex B Biotal Wastewater Treatment Technology

Biotal Site Visit Report (June 26, 2012)

James Gallup and Givi Varduashvili (TetraTech) and David Potskhishvili, Biotal/Tbilisi.

Site Visit to Biotal treatment facility at Saguramo IDP housing complex.

Site visit began with a discussion of the Biotal technology. How it operates and design criteria, operation and maintenance measures and treatment performance. Site visit to Biotal plant was at Suguramo IDP housing complex with about 110 families (at 4-5 members/family) at 200 liters/day/person equals about 100 m^3/day, the design capacity of the Biotal plant.

Biotal is a batch reactor activated sludge plant. Wastewater empties into an inlet holding tank before it is added to the first reactor, then second and third reactor. Reactor one and two are aerated for aerobic treatment and good mixing. After the third reactor, the effluent passes through a biofilter for final polishing and chlorination. There is no clarifier, the third reactor allows the sludge to settle before it is pumped to the biofilter. The effluent is pumped into an old elevated irrigation channel, it is not far from a small river. There is no flow measurement or effluent quality data. The observed treatment performance is principally done by smell (for odors) and clarity of effluent (visual). The effluent from the third reactor visually separated from sludge and the final discharge was clear. Treatment performance seemed good.

Sludge from the last reactor is pumped back into the first and second reactors, excess sludge goes into a sludge holding tank. At the beginning of 2012, Biotal had sludge pumped from the sludge tank and third reactor. It is expected that sludge will now be removed annually. We asked about performance, there were no problems with starting up after power failures, there was a stand-by generator but there is no diesel fuel for it. No problems have been encountered with pumps or compressors.

Biotal staff perform monthly maintenance of the facility. They are paid by the municipality although it is not easy to find a mechanism for payment. The local person who oversees the Biotal plant is mainly looking whether it is running, whether there are any emergency alarms or warning lights blinking. The local person visits only, doesn't do any O&M. Biotal expects the monthly maintenance fee to be 200-300 l/month. Additional Biotal design specifications and technical operating procedures are provided below.

Biotal Biological Wastewater Treatment. Biotal was designed to take advantage of the significant advantages of both continuous and discontinuous biological treatment systems and to avoid their disadvantages. Biotal utilizes new patented technologies including the siphon airlift, regulated siphon and the regulated airlift and reverse airlift. Also, new technologic systems were used including the accepting container - denitrificator (ACD), 3-stage reactor sequencing batch reactor (SBR), and Biofilter-Thin-Layered sedimentation (BFTL).

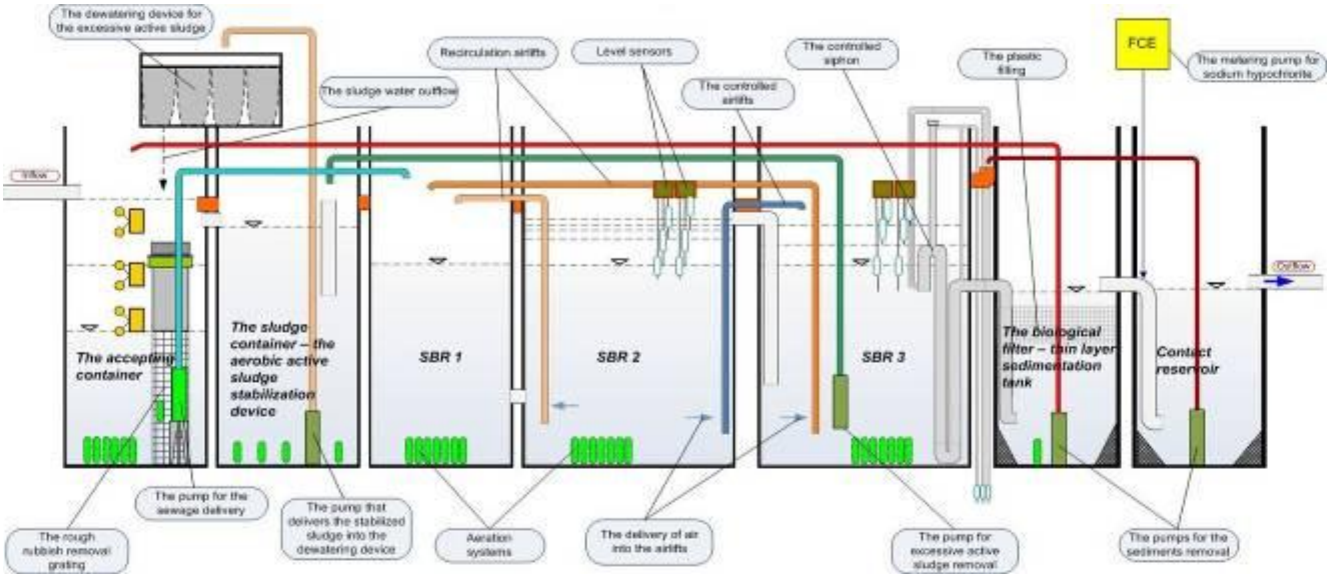
These system parts were selected because of their reliability. There are no moving parts and devices are made with magnetic valves that deliver air under one of six modes. In addition, Biotal is switched automatically by the MITSUBISHI controller based on the quantity of incoming sewage. The magnetic valves, ASCO (Netherlands), have strong capability, being able to switch millions of cycles. The automation of Biotal is made with modules of leading manufacturers - Mitsubishi, Moeller and others. Even the smallest Biotal plant is equipped with such automation. The system parts are more expensive than other competitors, but Biotal is much more reliable and the service group will easily make modifications, even replacing any module. If a compressor breaks down, the automation system will give an alarm signal, and the system will still work for at least 24 hours.

Biotal provides effective biological treatment with its fully automatized 6-stage and 3-sludge processing using self-regulated hydro-pneumo-biological processes with 4-planimetric recirculation of returnable active sludge. Biotal operates under a wide system dynamic that includes organic substances, nitrogen and phosphorous around 100:5:1. While these ratios do not occur all the time, Biotal allows bacteria of active sludge to leave what they haven't eaten; meaning that the multiplanimetric sludge recirculation and the multistage operating system makes these reactants to circulate together with the active sludge and the organisms are ready for new sewage where the incoming reactants may differ widely over time. In the end, microorganisms will eat parts of the sewage with each sludge recirculation cycle. Biotal has operating conditions for simultaneous removal of nitrogen and phosphorous in its patented operational methods. The alternation of aerobic and anaerobic conditions is combined with the age of sludge over 25 days. Facultative microorganisms take an active part in the Biotal purification process. This actually provides for effective removal of nitrogen and phosphorous.

The surplus active sludge is removed from the Biotal aerobic zone automatically because the phosphorous-absorbed by special bacteria in the aerobic zone dissolves as soon as it meets the anaerobic condition. The dehydrating of surplus sludge in the sludge tank of Biotal is made without addition any flocculating agent because of the significant age of active sludge (more than 25 days) and its strong mineralization, and also its long stabilization by aeration.

Biotal automatically switches into one of 6 programs: forced mode (when the quantity of sewage is more than the project one). With the absence of sewage into the plant, Biotal automatically passes in the first (in 1 hour), the second (in 24 hours) and into the third (in 168 hours) economical modes. It allows for reducing the need for electric power to prolong the service life of equipment and to provide for long live of the microorganisms of active sludge. For instance, when the sewage is absent for more than 7 days, the system passes into the third economic mode which saves up to 80% of energy as well as the long life of compressors and valves. Below is the technological scheme of Biotal plants that operate between 10 and 1,000 cubic meters per day.

Biotal operates in eight zones of sewage processing: 1) Trash bar-screen grate; 2) Accepting Container-Dentirificator (ACD); 3) First stage SBR reactor; 4) Second stage SBR reactor; 5) Third stage SBR reactor; 6) Aerated Biological Filter; 7) Thin-Layer Sedimentation tank; and 8) Contact Reservoir. There are also two zones of surplus active sludge processing: 9) Aerobic Active Sludge Stabilizer; and 10) Dewatering Module.



Biotal treatment plants consist of the Accepting Container-Denitrificator (ACD) with a net made of stainless steel for trash removal; three-stage SBR-reactor, the aerated biological filter with plastic inserts which also operate as a thin-layer sedimentation tank, contact reservoir and a surplus active sludge stabilizer with the dewatering system. In Biotal, microorganisms of different groups do not compete, they work effectively together to remove groups of specific pollutants and the sewage is gradually cleaned. Only in Biotal are the hydraulic connections between ACD and SBR-1, SBR-2 and SBR-3, SBR-3 and BFTST periodically interrupted according to the automated program. The hydraulic connections are performed: between ACD and SBR-1 - by the ACD-pumps, SBR-2 and SBR-3 - by the controlled airlifts or reverse airlifts, SBR-3 and BFTST by the controlled siphon, and BFTST and contact reservoir are connected by hydraulic openings. Going from one zone to another, the sewage is cleaned stage by stage in 6 - 8 phases according to one of six programs. The composition of automation phases differs for the economic mode - the pumping out of the cleaned sewage and the surplus sludge removal do not take place.

The Biotal system has three sludge systems: in ACD, in the three-stage SBR-reactor and in the BFTST system where the 4-planimetric recirculation of the returnable active sludge takes place. This construction of the system allows this three-sludge system, as the pumping of the sludge mixture takes place after the sedimentation in the appropriate container. The sludge in the plant are partly mixed during the recirculation before the sedimentation cycle.

The purification of the sewage in the BIOTAL plant takes place in this order: 1) Fresh sewage is processed in the ACD; 2) Sewage from the previous cycle is processed in the SBR-1 and SBR-2; 3) Sewage from the previous two cycles is processed in SBR-3; 4) Sewage from the previous three cycles is processed in the biological filter-thin-layer sedimentation tank; and 5) Sewage from the previous four cycles is processed in the contact reservoir. While being processed, the sewage gradually moves from the first to the last purification stage, which is provided by the temporary hydraulic connection between the reservoirs by the hydro-automatic devices.

Biotal has 6 - 8 phases, the quantity of which depends on the mode of the work of the plant. The sewage comes through the grate where trash is collected. After that the sewage flows into the accepting container-denitrificator (ACD), which works as an SBR-reactor, as an accumulating space for the irregular inflow of the sewage, and as a first-stage denitrificator. It contains the self-cleaning non-rusting grates for trash, the aerating and mixing systems, the self-cleaning level sensing elements, and the pumps that pump water into SBR-1. The fresh sewage is mixed with returnable active sludge from the SBR-3, which contains the nitrites and nitrates. During the mixing mode, the process of denitirification takes place and it has a double effect: the denitrification with the deliverance of gaseous nitrogen into the atmosphere and the oxidation of the organic pollutants of the fresh sewage with the oxygen of the nitrates and nitrites. The concentration of active sludge is constant due to the level of pumping of the previously cleaned sewage. The pumps that pump the mixture into the SBR-1 after sedimentation in ACD, pump out the surplus active sludge from ACD at the same time. Changing the height of the pumping level controls the concentration of the active sludge in ACD.

The previously cleaned sewage from ACD is pumped into the SBR-1. The SBR-1 is hydraulically connected with SBR-2 by an opening. The aeration in SBR-1 and SBR-2 is periodically interrupted according to the program, and the circulation of the mixture of sewage and active sludge occurs at all times. The second stage of denitrification takes place in SBR-1 during mixing. As the process of nitrification takes place in the SBR-2, and the returnable active sludge from SBR-2 contains enough of the nitrites and nitrates, there is still light organic in SBR-1. Denitrification intensifies when the aeration elements are in the mixing mode - when less air is given for aerating. In this case, denitrification in SBR-1 will take place even when there is aeration in SBR-2, that is, during all the processes of purification. After these reactors the sewage is pumped by the controlled airlifts into SBR-3 where they also remove scum so that the microorganisms in SBR-3 are not exposed to their negative effects. While the controlled airlifts are pumping the sewage into the third SBR reactor, the recirculation of the returnable active sludge is performed into the SBR-1 and ACD. The SBR-3 works as an aeration tank at first (where the processes of strong organic oxidation) and the second stage of nitrification take place. After switching off the aeration and the airlifts, it acts as a secondary sedimentation tank. The aeration, sedimentation and the pumping out of cleaned sewage by the controlled siphon into biofilter-thin-layer sedimentation tank (BFTST), and also the pumping out of the surplus active sludge into the stabilization container with additional (after stabilization) dewatering. During the aeration of SBR-3, the aeration of part of the biofilter takes place, resulting in the airlift effect in the cells which leads to the recirculation of cleaned sewage in the cells. The plastic filling of the biofilter is covered with a biological layer, and only the part with air provides oxidation (continues to oxydate the hard organic substances and provides the third stage of nitrification). Where air doesn't reach, this provides the third stage of denitrification. The cleaned sewage from the third reactor comes to the lower part of BFTST, after the aeration, the sedimentation and the surplus sludge removal is stopped. The sewage cleared in previous cycle in BFTST is displaced by the sewage from SBR-3, and it moves upwards through the plastic filling to remove five times weight of classic sedimentation. The replaced sewage flows into the contact reservoir where disinfection takes place. The control display of Biotal shows these parameters:

- The total time of work of the ACD pump, counting from the first start (hours);
- The number of times the clean sewage was pumped out;
- The number of times the clean sewage was pumped out per week;
- The total number of times the cleaned sewage was pumped out from the first start;
- The total time of plant operation;
- The number of times surplus sludge was pumped out and the time of pumping;
- The time of switching of the siphon and clean water valves;
- The time of pumping out of the sedimentation from the BFTST and contact reservoir;
- The time of metering pump work;
- The sedimentation time;
- The emergency switching of the ACD pumps.

All the work parameters of the Biotal plant can be observed. As the composition and the inflow dynamics of sewage, the Biotal service group can adjust plant operation and automation systems. The standard programs of Biotal plants are made for household sewage, so there is usually no need to change them for applications such as IDP cottage settlements.

Annex C Biotal Installations in Georgia

Biological Treatment Facility "Biotal", installed in Georgia by Construction Systems

No	Date	Capacity m^3/hr	Location	Note
1	01.08.07	3	Mestia, Airport	Operating
2	16.02.08	2	Tsavkisi, Private villa	Operating
3	21.05.08	4	Village Mukhrani, "Shato Mukhrani"	Operating
4	17.10.08	100	Tsavkisi, "Tsavkisis Veli"	Operating
5	24.12.08	4	Batumi, Customs Terminal	Operating
6	28.01.09	4	Lilo Pharmaceutical Factory	Operating
7	11.02.09	6	Akhaltsikhe, Veterinary Laboratory	Operating
8	27.05.09	4	Batumi, Tourist Complex	Operating
9	24.11.09	3	Tskhaltubo, Tourist Complex	Operating
10	25-09-10	30	Anaklia, Hotel	Operating
11	30-07-10	40	Didi Lilo, Landfill	Operating
12	15-08-10	3	Tbilisi, "Wood service" Office	Operating
13	25.10.10	100	Saguramo, IDP housing	Operating
14	15.11.10	4	Kutaisi, Sataplia Cave	Operating
15	15.11.10	5	Kutaisi, Sataplia Cave	Operating
16	15.11.10	6	Kutaisi, Sataplia Cave	Operating
17	12.2010	250	Ganmukhuri Boulevard	Operating
18	08.12.2011	125	Ksani, Ksani Colony	Temporarily not operating
19	31.03.11	50	Zugdidi, IDP housing	Temporarily not operating
20	30.04.11	10	Gori, resting place nearby the highway	Operating
21	30.04.11	4	Batumi Botanical Garden	Operating
22	30.04.11	2	Batumi Botanical Garden	Operating
23	30.04.11	4	Boriti Hospital	Installed; not launched yet
24	05.11	1.5	Kaspi Hospital	Operating
25	30.04.11	20	Gori, resting place nearby the highway	Operating
26	05.11	1.5	Ozurgeti Hospital	Operating
27	09.01.2012	6	Samtredia Hospital	Operating
28	09.01.2012	1.5	Samtredia Hospital	Operating
29	11.01.2012	4	Baghdati Hospital	Operating
30	11.01.2012	1.5	Baghdati Hospital	Operating
31	04.11.2011	4	Khazbegi Hospital	Operating
32	04.11.2011	1.5	Khazbegi Hospital	Operating
33	19.09.2011	10	Mtskheta Hospital	Operating
34	19.09.2011	1.5	Mtskheta Hospital	Operating
35	07.01.2012	4	Tianeti Hospital	Operating
36	07.01.2012	1.5	Tianeti Hospital	Operating
37	29.09.2011	1.5	Dusheti Hospital	Operating

Biological Treatment Facility “Biotal”, installed in Georgia by Construction Systems

No	Date	Capacity m^3/hr	Location	Note
38	05.01.2012	1.5	Borjomi Hospital	Operating
39	13.12.2011	1.5	Bakuriani Hospital	Operating
40	23.09.2011	1.5	Sagarejo Hospital	Operating
41	23.09.2011	1.5	Kutaisi Hospital	Operating
42	10.10.2011	1.5	Kutaisi Hospital	Operating
43	10.10.2011	1.5	Khoni Hospital	Operating
44	10.10.2011	1.5	Terjola Hospital	Operating
45	10.10.2011	1.5	Tkibuli Hospital	Operating
46	07.11.2011	1.5	Ambrolauri Hospital	Operating
47	07.11.2011	1.5	Oni Hospital	Operating
48	16.11.2011	1.5	Mestia Hospital	Operating
49	10.11.2011	1.5	Bolnisi Hospital	Operating
50	10.11.2011	1.5	Dmanisi Hospital	Operating
51	07.11.2011	1.5	Tsageri Hospital	Operating
52	07.11.2011	1.5	Khashuri Hospital	Operating
53	07.11.2011	1.5	Surami Hospital	Not installed yet
54	05.03.2012	10	Tsnori Hospital	Operating
55	26.11.2011	1.5	Tsnori Hospital	Operating
56	26.11.2011	1.5	Lagodekhi Hospital	Operating
57	01.12.2011	12	Poti Hospital	In the process of installation
58	01.12.2011	1.5	Poti Hospital	In the process of installation
59	01.12.2011	1.5	Tsalenjikha Hospital	Operating
60	01.12.2011	4	Tsalenjikha Hospital	Operating
61	01.12.2011	1.5	Martvili Hospital	Operating
62	01.12.2011	4	Martvili Hospital	Operating
63	01.12.2011	1.5	Senaki Hospital	Not installed yet
64	01.12.2011	4	Senaki Hospital	Not installed yet
65	01.12.2011	1.5	Chkhorotsku Hospital	Not installed yet
66	01.12.2011	4	Chkhorotsku Hospital	Not installed yet
67	20.03.2011	6	Poti, Freezer Terminal	Operating
68	20.03.2011	3	Kvareli, president’s Vineyard	Operating
69	15.06.2011	40	Sachkhere, village Corvila	Operating
70	20.03.2012	60	Sachkhere, village Corvila	Not installed yet
71	25.03.2011	10	Martkhofi, (rugby stadium)	Not installed yet
72	25.03.2012	16	Ninotsminda,(rugby stadium)	Not installed yet
73	31.03.2011	10	Didi Jikhaishi	Operating
74	13.04.2012	6	Kvareli, Lopota	Operating
75	10.05.2012	4	Tskaltubi, Cave	Operating
76	29.03.2012	25	Red Bridge	Operating

Biological Treatment Facility “Biotal”, installed in Georgia by Construction Systems

No	**Date**	**Capacity m^3/hr**	**Location**	**Note**
77	**29.03.2012**	**20**	Sadakhlo	Operating
78	**29.03.2012**	**10**	Tbilisi, Restourant "Ekipazhi"	In the process of installation
79	**29.03.2012**	**4**	Lilo, LTD "Insta"	In the process of installation

Annex D Treatment Technology BOQs and Feasibility Drawings

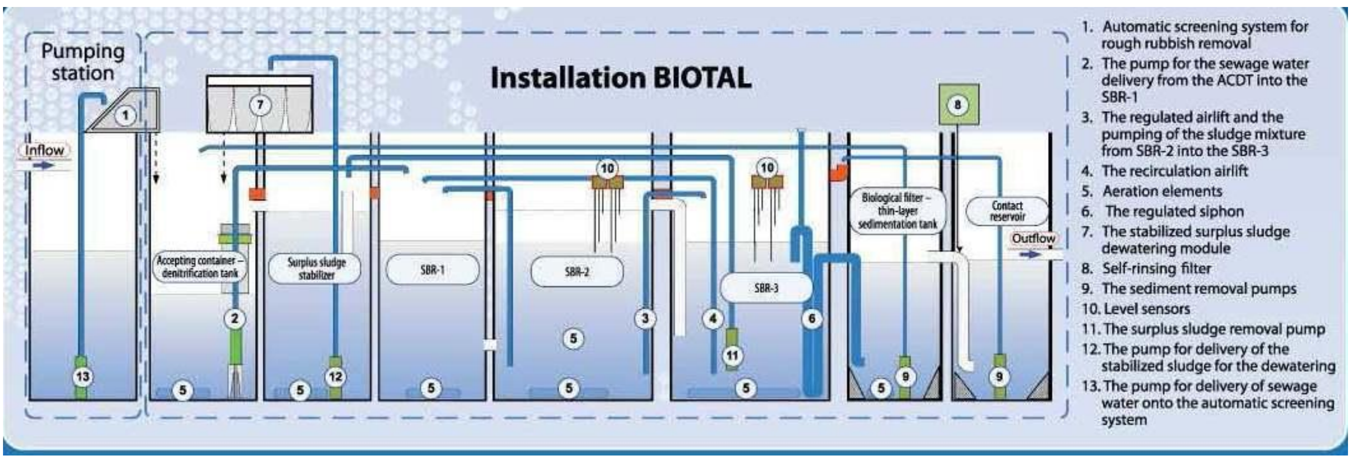
Treatment Technologies

1. Biotal Biological Treatment
2. Aerated Lagoons
3. Septic Tanks and Infiltration Drain Fields

Annex D1: Biotal Package Treatment System

Cottage settlements		Capital cost	Annual O & M costs/USD			
			Biotal			
			Labor	Energy	Service	Total
1	Akhalsopeli	72788	1455	2124	1673	5252
2	Mokhisi	50120	1455	1702	1455	4612
3	Skra	72788	1455	2124	1673	5252
4	Berbuki	85773	1455	2313	1818	5586
5	Shavshvebi	99316	1455	2313	1818	5586
6	Khurvaleti	85773	1455	1702	1818	4975
7	Teliani	50120	1455	8851	1455	11761
8	Tsilkani	225826	1455	882	2182	4519
9	Frezeti	158671	1455	882	1818	4155
10	Metekhi	40288	1455	1702	1455	4612

Biotal Technological Scheme



Annex D 2: Aerated Lagoon

Cottage Settlement Aerated Lagoon Costs (USD)
One Lagoon Costs

#	Cottage Settlement	Cottages	People	Area (m2)	Capital	O&M			
						Labor	Energy	Service	Total
1	Akhalsopeli	100	350	10X10 = 100	39,394	732	1274	703	2709
2	Mokhisi	58	220	10X10 = 100	39,394	732	1274	703	2709
3	Skra	86	312	10X10 = 100	39,394	732	1274	703	2709
4	Berbuki	134	460	10X15 =150	59,091	800	1487	703	2990
5	Shavshvebi	177	586	10X20 =200	78,788	876	1699	703	3278
6	Khurvaleti	139	460	10X15 =150	59,091	800	1487	703	2990
7	Teliani	54	164	10X10 = 100	39,394	732	1274	703	2709
8	Tsilkani	400	1093	10X20 =200	78,788	876	1699	703	3278
9	Frezeti	300	721	10X20 =200	78,788	876	1699	703	3278

Descriptions of O&M Costs

1) Labor (Local Supervisor Salary)

- Lagoon Area (10X10=100 Sq m) – 61 /Month – 732 /Year
- Lagoon Area (10X15=150 Sq m) – 67 /Month – 804 /Year
- Lagoon Area (10X20=200 Sq m) – 73 /Month – 876 /Year

2) Electricity Cost for Aerator

- Lagoon Area (10X10=100 Sq m); 1 Aerator – 3 kW/h X 2 = 6kW/h

Working Length 6 hours per full day = 6 kW/h X 6 h = 36 kW/h
Electricity Tariff 0.16 GEL; 36kW/h X 0.16 GEL = 5.76 GEL per full day
Annual Cost: 5.76 GEL X 365 Days = 2102 GEL – 1274

- Lagoon Area (10X15=150 Sq m); 1 Aerator – 3.5 kW/h X 2 = 7 kW/h

Working Length 6 hours per full day = 7 kW/h X 6 = 42 kW/h
Electricity Tariff 0.16 GEL; 42 kW/h X 0.16 GEL = 6.72 GEL per full day
Annual Cost: 6.72 GEL X 365 Days = 2453 GEL – 1487

- Lagoon Area (10X20=200 Sq m) 1 Aerator – 4 kW/h X 2 = 8 kW/h

Working Length 6 hours per full day = 8 kW/h X 6 = 48 kW/h
Electricity Tariff 0.16 GEL; 48 kW/h X 0.16 GEL = 7.68 GEL per full day
Annual Cost: 7.68 GEL X 365 Days = 2803 GEL – 1699

- Service: removing disposals by cesspool emptier 8 times a year.
- Cost of a vehicle fuel – 25 GEL X 8 = 200 GEL
- Vehicle exploitation and driver salary 120X8=960 GEL
- Total: 1160 GEL – 703

Note: Work of the floater is determined by the amount of flowed mass.

BOQ for Aerated Lagoon (one lagoon)

№	Work title	Dimension	Cost				Note
			one	total	one	total	
1	To dig caldron for lagoon; 3rd category of soil; 12•10	m^3	702	2.8	19656		Aerated biological lagoon
2	To load soil in the track and place 5 km away	m^3/ton	622	2.0	1244		
3	To ram the bed and walls of the caldrons with vibrant rammer	m^2	660	4.0	2640		
4	Initial points of pipes for sewerage water	m^3	2•4	127	1016		
5	Waterproof screen with clay layer for bottom and walls to protect from water loss	m^2	600	10	6000		
6	To cover with geotextiles on clay screen and walls	m^2	660	42	27720		
7	To install floating aerator	unit	2	-	10000		No information
8	To install chlorination unit per 1 kg of chlorine	kg		55000	55000		
9	To arrange sanitation fence with gate and wicket	m^2		8.5	2550		Wire net; 20·15m
10	Sentry bow; 3•4m	unit			3000	3000	
11	To restore part of soil cover and surface it with geotextiles	m^3			3.0	240	

Total cost: 1,290,066

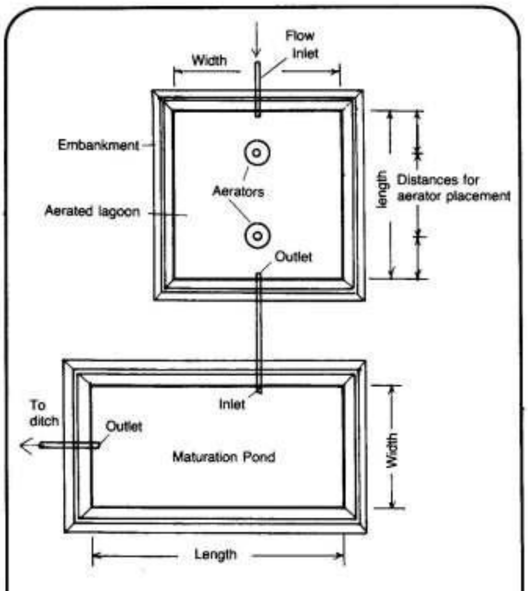


Figure 2. Design of Aerated Lagoon System

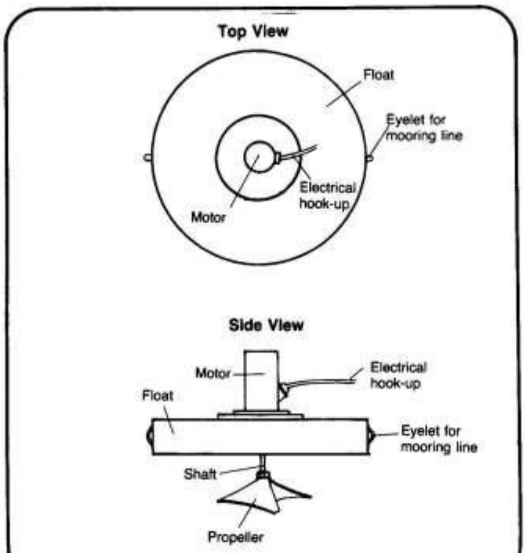


Figure 3. Aerator

Determining Labor, Materials, and Tools

The primary labor requirement is an engineer experienced with mechanically aerated lagoons. A fairly large and reliable work force of 5-20 people is needed. At least one worker must be a skilled electrician. One or more workers should have some experience with concrete mortar. Because of the size of the excavation, motorized excavating equipment, such as a backhoe, may be needed.

Materials needed include the aerators and all necessary wiring and spare parts; flat stones an mortar for lining the lagoons; sewer pipe and valves for inlet and outlet pipes and interpond piping; grass seed or sod for the top and outside of embankments. Tools needed include those used for assembling and installing electrically powered aerators, spreading mortar, laying pipe, and laying sod.

When all decisions on labor, supplies and tools have been made, prepare a materials list similar to Table 1 and give it to the construction foreman.

Table 1. Sample Materials List for Aerated Lagoon

Item	Description	Quantity	Estimated Cost
Labor	Engineer experienced with aerated lagoons	1	____
	Electrician	1	____
	Worker skilled with concrete mortar	1	____
	Unskilled workers	5	____
	Backhoe operator	1	____
Supplies	Aerators, including spare parts, electric cables, and mooring lines	____	____
	Sewer pipe, 100mm diameter	____	____
	Valves, 100mm diameter	____	____
	Flat stones	____	____
	Mortar mix	____	____
	Grass seed	____	____
Tools	Backhoe	____	____
	Shovels	____	____
	Electrician's tools	____	____
	Mixing containers	____	____
	Trowels	____	____

Total Estimated Cost = ____

Annex D 3: Septic tanks and infiltration field

Central Septic Tank: Central Septic Tank w Infiltration Field Cost (USD)										
№	Location	Cottages	Persons	Area (m^2)	Capital	O&M Cost				Infiltration rate
						Labor	Energy	Parts/ Equip	Total	
1	Akhalsopheli	100	350	5724	60,205	727	–	270	997	1.5
2	Mokhisi	58	220	540	10,946	727	–	270	997	1.5
3	Skra	86	312	1998	28,200	727	–	270	997	1.5
4	Berbuki	134	460			727	–	270	997	0
5	Shavshvebi	177	586	3300	46,159	727	–	556	1284	1.5
6	Khurvaleti	139	460	7982	83,770	727	–	270	997	1.5
7	Teliani	54	164			727	–	270	997	0
8	Tsilkani	400	1093	9288	119,772	727	–	556	1284	According Geological research results
9	Frezeti	300	721	17244	177,667	727	–	556	1284	0.3

Definitions for O&M costs:

1. Human resources: (salary for local supervisor):
    - Duties include supervision and cleaning of watching well in case of need; salary – 100 GEL (monthly), 1200 GEL (yearly) – 727 .
2. Service: Cleaning of infiltration net (piping) is conducted by compressor (), by mixture of air and water:
    - Cleaning is required once a year if the number of population is below 500 – 300 GEL (cost for mechanism and worker);
    - Cleaning is required twice a year if the number of population is more than 500 – 600 GEL (cost for mechanism and worker);
    - Removal of remain sludge from treatment facility by cesspool emptier once a year if the number of population is below 500.
        a. Fuel cost for the vehicle – 25 GEL;
        b. Vehicle maintenance and driver's salary – 120 GEL;
        c. Contingencies – 3% (300 GEL+25 GEL+120 GEL)+13 GEL; in total: 458 GEL=270 .
    - If the number of population exceeds 500, the same volume of works should be conducted twice a year: (600 GEL+50 GEL+240 GEL=890 GEL+ (3%)28 GEL=918 GEL=556).
3. The area for infiltration field diameters of the pipes will be specified after elaborating draft project. We have considered approximate space near the actual one (12X6+72 m^2 – below 500 settlers and 16mX6m=96m^2 – more than 500 settlers).
4. Geological research and infiltration test will be conducted in Tsilkani, as for Mokhisi and Frezeti, only infiltration tests. As a result certain data from the list will be specified.

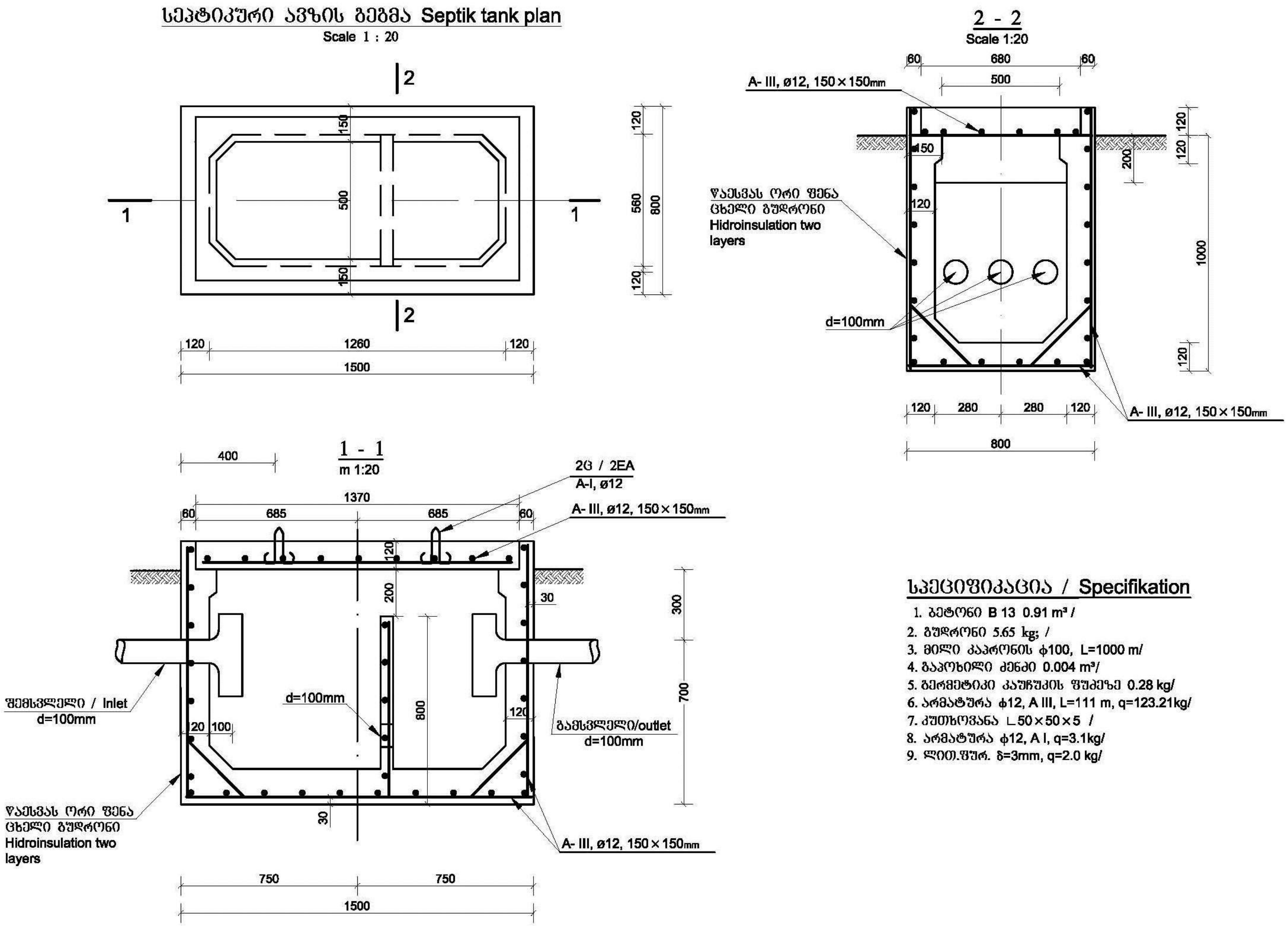
In the following settlements central sewage system with separate septic tanks per cottage and infiltration field must be constructed.

Table: On-Site Waste Water Treatment Infiltration fields with septic tanks (one per cottage)

# GEO	Location	IDP information		Type of project with cost in WWTF Construction (septic tank with Infiltration/drainage field)[1]	
	City / Village	# of HH	# of Individuals	Infiltration field dimensions	Cost
0	4	28	29	34	35
1	Akhalsopeli	100	350	94x60m	97,027
2	Mokhishi	58	220	9x60m	29,350
3	Skra	86	312	33.3x60m	53,942
4	Shavshevbi	177	586	55x60m	102,494
5	Khurvaleti	139	460	133.2x60m	133,642
6	Tsilkani	400	1,093	158.4x60m	243,185
7	Frezeti	300	721	192x60m 94.4x60m	288,320
					948,000

BOQ for Individual septic tank

	Name of Work	U.O.M	Quantity	Unit price	Total GEL	Total
	Septic tank					
1	Excavate the pit for septic tank	M^3	2	20	40	
2	Form and pour the concrete septic tank with partition, access manhole and associated piping 1.5mx1.0mx0.8m	U	1	500	500	
3	Apply two layers of hydro-insulation around the tank	M^2	6	10	60	
4	Backfill around the septic tank	M^3	0.8	15	12	
5						
6	Sum				612	370


Septik tank plan
Scale 1 : 20
2 - 2
Scale 1:20
1 - 1
m 1:20
Hidroinsulation two layers
d=100mm
A- III, ø12, 150×150mm
A-I, ø12
Inlet
d=100mm
outlet
d=100mm
Specifikation
1. B 13 0.91 m³ /
2. 5.65 kg; /
3. ϕ100, L=1000 m/
4. 0.004 m³/
5. 0.28 kg/
6. ϕ12, A III, L=111 m, q=123.21kg/
7. ∟50×50×5 /
8. ϕ12, A I, q=3.1kg/
9. δ=3mm, q=2.0 kg/

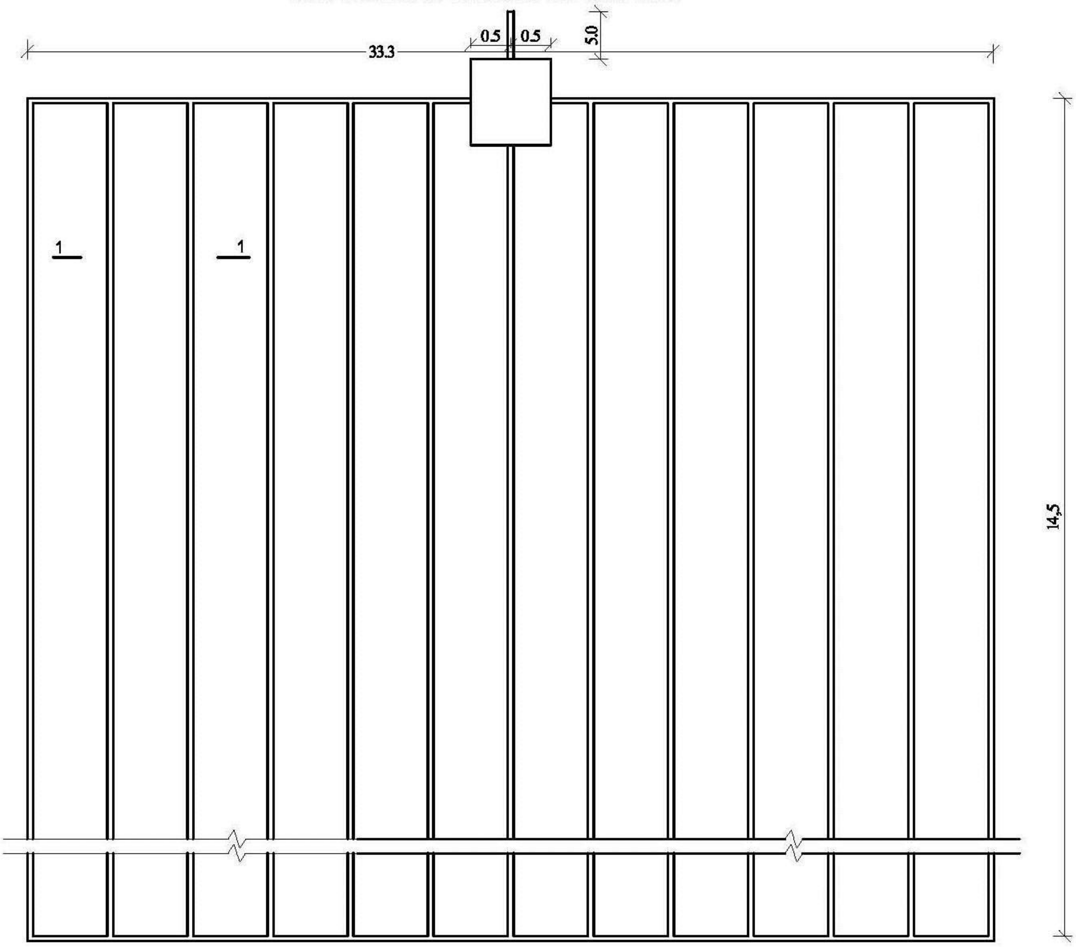
BOQ for Skra settlement 86 cottages, infiltration field area 1998m^2

#	Description of work	UOM	Q-ty	Unit price	Total in GEL	Total in
1	Excavation of tranches by 0,5m^3 excavator and transportation up to 5km	M^3	878.4	7.4	6500.2	3939.5
2	Installation of perforated plastic pipes d=100	L.m	819.3	6	4915.8	2979.3
3	Install sewage distribution box 1mx1mx1m	U	1	700	700	424.24
4	PVC elbow 90^0 d=100mm	U	2	2.1	4.2	2.6
5	PVC TEE d=100mm	U	10	3.8	38	23.03
6	Fill tranches with clean rocks 20-50mm (washed ballast)	M^3	730	17.6	12848	7786.7
7	Barrier material (Geotex)	M^2	732	5	3660	2218.2
8	Manual backfill of tranches h=20cm	M^4	146.4	10.65	1558.5	944.5
9	Fencing around the infiltration field	L.m	206	17.4	3584.4	2172.4
10	Sum				33809.1	20490.47
11	Contingency 10%				3381	2049.0
	Sum				37190	22539

Drawing below is just for Skra settlement, it shows typical components of infiltration fields,

for other settlement infiltration fields, length of the Pipes will be same 60m, only width will be changed according to provided infiltration field areas.

ლტოლვილთა ჩასახლება „სკრა“ (გორის მუნიციპალიტეტი) 86 ოჯახი - 312 სული.
ინფილტრაციული სადრენაჟო მინდვრის სქემა



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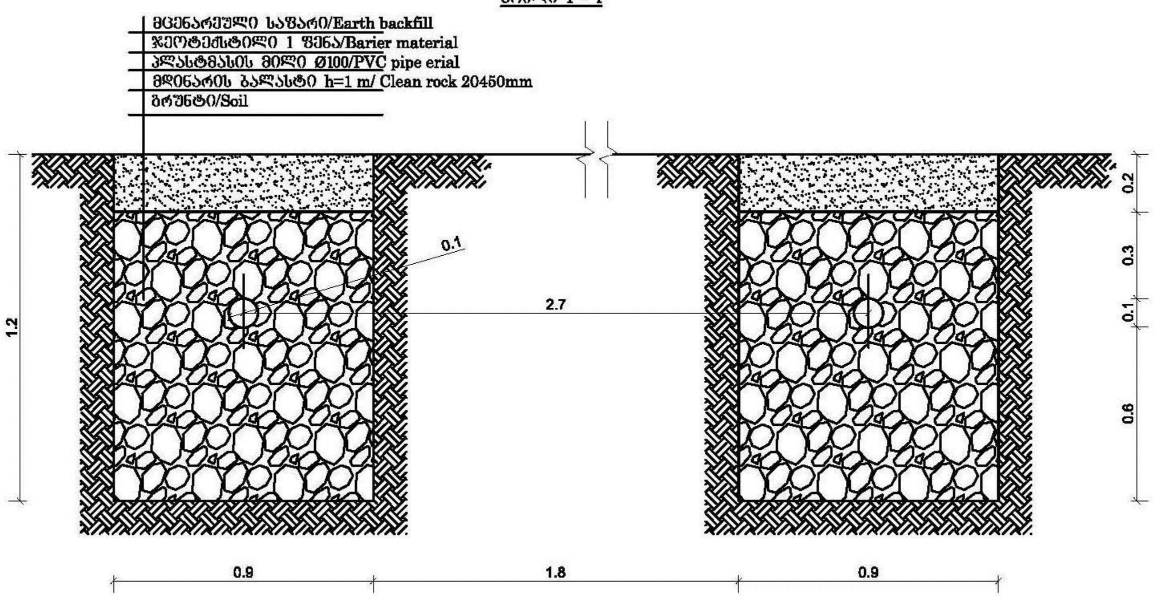

Akhalsopeli 100 cottages Infiltration field area 57240M^2

#	Description of work	UOM	Q-ty	Unit price	Total in GEL	Total in
1	Excavation of tranches by 0,5m^3 excavator and transportation up to 5km	M^3	2441.23	7.4	18065.10	10948.55
2	Manual backfill of tranches h=20cm	M^3	507.0	10.65	5399.55	3272.45
3	Installation of perforated plastic pipes d=100	L.m	2260.4	5.1	11528.04	6986.69
4	Install sewage distribution box 1mx1mx1m	U	1	700.0	700.00	424.24
5	PVC elbow 90^0 d=100mm	U	2	2.1	4.20	2.55
6	PVC TEE d=100mm	U	32.0	3.8	121.60	73.70
7	Fill tranches with clean rocks 20-50mm (washed balast)	M^3	2035.0	17.6	35816.00	21706.67
8	Insulation layer (Geotex)	M^2	2036.0	5.0	10180.00	6169.70
9	Fencing around the infiltration field	L.m	350.8	17.4	6103.92	3699.35
Sum					87918.41	53283.89
Contingency 10%					8798.84	5328.39
Sum					96717.25	58612.28

Mokhisi 58 cottages, infiltration field area 540m^2

#	Description of work	UOM	Q-ty	Unit price	Total in GEL	Total in
1	Excavation of tranches by 0,5m^3 excavator and transportation up to 5km	M^3	226.00	7.4	1672.4	1013.58
2	Manual backfill of tranches h=20cm	M^3	75.20	10.65	800.88	485.382
3	Installation of perforated plastic pipes d=100	L.m	254.00	5.1	1295.4	785.09
4	Install sewage distribution box 1mx1mx1m	U	1	700.0	700	424.24
5	PVC elbow 90^0 d=100mm	U	2	2.1	4.2	2.55

6	PVC TEE d=100mm	U	2	3.8	7.6	4.61
7	Fill tranches with clean rocks 20-50mm (washed balast)	M^3	224.00	17.6	3942.4	2389.33
8	Insulation layer (Geotex)	M^2	216.00	5.0	1080	654.55
9	Fencing around the infiltration field	L.m	178.00	17.4	3097.2	1877.09
Sum					12600.08	7636.41
Contingency 10%					1260.01	763.64
Sum					13860.09	8400.05

Savshvebi 177 cottages, infiltration field area 3300M^2

#	Description of work	UOM	Q-ty	Unit price	Total in GEL	Total in
1	Excavation of tranches by 0,5m^3 excavator and transportation up to 5km	M^3	1193.40	7.4	8831.16	5352.22
2	Manual backfill of tranches h=20cm	M^3	394.80	10.65	4204.62	2548.25
3	Installation of perforated plastic pipes d=100	L.m	1320.00	5.1	6732	4080.00
4	Install sewage distribution box 1mx1mx1m	U	1	700.0	700	424.24
5	PVC elbow 90^0 d=100mm	U	2	2.1	4.2	2.55
6	PVC TEE d=100mm	U	19	3.8	72.2	43.76
7	Fill tranches with clean rocks 20-50mm (washed balast)	M^3	1188.00	17.6	20908.8	12672
8	Insulation layer (Geotex)	M^2	1188.00	5.0	5940.00	3600.00
9	Fencing around the infiltration field	L.m	270.00	17.4	4698.00	2847.27
Sum					52090.98	31570.29
Contingency 10%					5209.10	3157.03
Sum					57300.08	34727.32

Khurvaleti 139 cottages, infiltration field area 7992m^2

#	Description of work	UOM	Q-ty	Unit price	Total in GEL	Total in
1	Excavation of tranches by 0,5m^3 excavator and transportation up to 5km	M^3	2825.25	7.4	20906.85	12670.82
2	Manual backfill of tranches h=20cm	M^3	940.00	10.65	10011	6067.27
3	Installation of perforated plastic pipes d=100	L.m	3138.20	5.1	16004.82	9699.89
4	Install sewage distribution box 1mx1mx1m	U	1	700.0	700	424.24
5	PVC elbow 90^0 d=100mm	U	2	2.1	4.2	2.55
6	PVC TEE d=100mm	U	48	3.8	182.4	110.55
7	Fill tranches with clean rocks 20-50mm (washed balast)	M^3	2824.38	17.6	49709.088	30126.72
8	Insulation layer (Geotex)	M^2	2824.38	5.0	14121.9	8558.73
9	Fencing around the infiltration field	L.m	426.40	17.4	7419.36	4496.58
Sum					119059.62	72157.34
Contingency 10%					11905.96	7215.73
Sum					130965.58	79373.07

Wilkani 400 cottages, Infiltration field area 154.8x60=9288 m^2

#	Description of work	UOM	Q-ty	Unit price	Total in GEL	Total in
1	Excavation of tranches by 0,5m^3 excavator and transportation up to 5km	M^3	3271.18	7.4	24206.73	14670.75
2	Manual backfill of tranches h=20cm	M^3	1090.40	10.65	11612.76	7038.04
3	Installation of perforated plastic pipes d=100	L.m	3639.80	5.1	18562.98	11250.29
4	Install sewage distribution box 1mx1mx1m	U	1	700.0	700.0	424.24

5	PVC elbow 90^0 d=100mm	U	2	2.1	4.20	2.55
6	PVC TEE d=100mm	U	56	3.8	212.80	128.97
7	Fill tranches with clean rocks 20-50mm (washed balast)	M^3	3275.82	17.6	57654.43	34942.08
8	Insulation layer (Geotex)	M^2	3275.82	5.0	16379.10	9926.73
9	Fencing around the infiltration field	L.m	469.60	17.4	8171.04	4952.15
Sum					137504.04	83335.78
Contingency 10%					13750.40	8333.58
Sum					151254.44	91669.36

Frezeti-1 200 cottages infiltration field area 11520m^2

#	Description of work	UOM	Q-ty	Unit price	Total in GEL	Total in
1	Excavation of tranches by 0,5m^3 excavator and transportation up to 5km	M^3	4006.16	7.4	29645.58	17967.02
2	Manual backfill of tranches h=20cm	M^3	1334.80	10.65	14215.62	8615.53
3	Installation of perforated plastic pipes d=100	L.m	4457.00	5.1	22730.70	13776.18
4	Install sewage distribution box 1mx1mx1m	U	1	700.0	700.00	424.24
5	PVC elbow 90^0 d=100mm	U	2	2.1	4.20	2.55
6	PVC TEE d=100mm	U	69	3.8	262.20	158.91
7	Fill tranches with clean rocks 20-50mm (washed balast)	M^3	4006.80	17.6	70519.68	42739.20
8	Insulation layer (Geotex)	M^2	4006.80	5.0	20034.00	12141.82
9	Fencing around the infiltration field	L.m	544.00	17.4	9465.60	5736.73
Sum					167577.58	101562.17
Contingency 10%					16757.76	10156.22
Sum					184335.34	111718.39

Frezeti-2 100 cottages infiltration field area 11520m2

#	Description of work	UOM	Q-ty	Unit price	Total in GEL	Total in
1	Excavation of tranches by 0,5m^3 excavator and transportation up to 5km	M^3	2441.23	7.4	18065.10	10948.55
2	Manual backfill of tranches h=20cm	M^3	507.0	10.65	5399.55	3272.45
3	Installation of perforated plastic pipes d=100	L.m	2260.4	5.1	11528.04	6986.69
4	Install sewage distribution box 1mx1mx1m	U	1	700.0	700.00	424.24
5	PVC elbow 90^0 d=100mm	U	2	2.1	4.20	2.55
6	PVC TEE d=100mm	U	32.0	3.8	121.60	73.70
7	Fill tranches with clean rocks 20-50mm (washed balast)	M^3	2035.0	17.6	35816.00	21706.67
8	Insulation layer (Geotex)	M^2	2036.0	5.0	10180.00	6169.70
9	Fencing around the infiltration field	L.m	350.8	17.4	6103.92	3699.35
Sum					87918.41	53283.89
Contingency 10%					8798.84	5328.39
Sum					96717.25	58612.28

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